

Folks,

CSP 1100(C), Operating Instructions for ECM Mark 2 (CSP 888/889) and CCM Mark 1 (CSP 1600) describes the high level United States cipher machine of WW II. More background on this machine and an Army manual may be found at:
<http://www.maritime.org/ecm2.htm>

In this online version of the manual we have attempted to keep the flavor of the original layout while taking advantage of the Web's universal accessibility. Different browsers and fonts will cause the text to move, but the text will remain roughly where it is in the original manual. In addition to errors we have attempted to preserve from the original this text was captured by optical character recognition. This process creates errors that are compounded while encoding for the Web.

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Richard Pekelney
Webmaster

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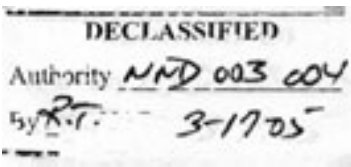
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OPERATING INSTRUCTIONS FOR

ECM MARK 2
(CSP 888/889)

AND
CCM MARK 1
(CSP 1600)

CONFIDENTIAL



CONFIDENTIAL

CSP 1100(C)

NAVY DEPARTMENT

OFFICE OF CHIEF OF NAVAL OPERATIONS


WASHINGTON

16 MAY 1944

ECM OPERATING INSTRUCTIONS

1. CSP 1100(C) is effective upon receipt.
2. CSP's 888, 889, and 1600 and associated publications shall not be used until the instructions contained herein have been read and thoroughly understood.
3. This publication is distributed to actual and potential holders of CSP's 888, 889, 1600 and associated publications.
4. CSP 1100(C) is a CONFIDENTIAL registered publication and shall be handled, stowed, transported and accounted for in accordance with the current edition of the Registered Publication Manual (RPS-4). This publication shall be destroyed by burning thirty (30) days after the end of its effective period. It shall not be carried in aircraft for use therein.
5. The use of this publication by enlisted members of Coding Boards, and by the authorized ECM repair personnel of ECM Repair Facilities is authorized. In such cases, the publication is to remain in the potential custody of a commissioned officer.

THIS PUBLICATION CONSISTS OF
SEVENTY-SIX (76) PAGES



JOSEPH R. REDMAN,
Rear Admiral, USN,
Director of Naval Communications

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ARMY-NAVY JOINT POLICY CONCERNING DISTRIBUTION
AND DISCLOSURE OF CRYPTOGRAPHIC
DESIGN OF THE ECM-M134C

On June 26, 1942 the Army and Navy jointly agreed on the following policy:

"It is mutually agreed that the ECM-M134C will not be placed ashore in foreign territory except at such places where armed personnel of U.S. forces are stationed in sufficient numbers to properly safeguard the physical security of the machine.

"The Army or Navy may make the machine available to the Allies of the United States if the machine is accompanied by a Liaison Officer and Communication Group. It will be the duty of the Liaison Officer to prevent the viewing of the machine or its operation or associated equipment by other than authorized personnel of U.S. armed forces.

"The U.S. Army and Navy mutually agree that they will regard as secret information to be divulged only to the armed forces of the U.S. or to any U.S. citizen required to possess this information in the interests of the United States, any details concerning the ECM-M134C including rotors, wiring diagrams, keys, keying instructions and operating instructions.

"If at any time either the Army or the Navy considers it necessary to deviate in any way from this policy, the one shall fully inform the other of the facts and circumstances and the change in policy, if any, shall be by joint agreement."

STRICT COMPLIANCE WITH THIS POLICY IS DIRECTED.

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THE TYPE 8 SAFE LOCKER
and
THE ECM MK 2

PLATE 1

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Version 1.01, 16 May 05

PART I

GENERAL

101. LOCATION

- (a) The ECM Mark 2 should be installed in the Type 8 Safe Locker. The regular location for the installation of the ECM Mark 2 is in the Code Room. Where there is no Code Room on the ship or station, the ECM shall be located where it will be protected from the weather, high humidity, excessive ranges of temperatures and espionage. The location should be suitable for regular operation of the ECM by enlisted personnel of the Coding Board and under sufficient surveillance to prevent theft or tampering. Observation of the ECM in operation should be a minimum compatible with the above requirements. The Chart House, Ward Room passageway or Radio Room would probably be suitable locations, while the Ward Room or Captain's Cabin probably would not be. In choosing the location, it should be noted that the ECM and the Cipher Unit (exclusive of Code Wheels) are classified CONFIDENTIAL, but the Key Lists, Code Wheels, etc. are classified SECRET.
- (b) In a temporary installation, the wooden box in which the ECM Mark 2 is shipped may be provided with hinges and a good padlock for temporary stowage.
- (c) Aboard ship, the ECM Mark 2 must be securely fastened, in both the operating and stowage positions to insure that under no conditions will it be liable to injury due to motion of the ship. Quarter-inch, 20 thread bolt-holes are provided in the base of the machine for securing it in place.
- (d) The Type 8 Safe Locker can be considered suitable stowage except at shore stations where it may be unobserved for long periods of time. Due to its special design, the Type 8 Safe Locker cannot be considered as secure as standard safes which are normally provided for the stowage of classified publications.

102. TYPE 8 SAFE LOCKER (See PLATE 1)

- (a) The Type 8 Safe Locker (BuShips No. 434, 703) is designed for the permanent installation of the ECM Mark 2. The Type 8 Safe Locker should be procured by all activities holding the ECM Mark 2. Class 4 and above activities having Coding Rooms in which a continuous 24 hour watch is maintained, may or may not use the Type 8 Safe Locker at discretion.
- (b) The Type 8 Safe Locker is procured by request (letter, not requisition) direct to the Navy Yard, Norfolk. It is not listed in standard stock catalogs. It is Title "A" equipment and is priced at \$90.00. When possible, procurement should be accomplished before actual receipt of the ECM Mark 2.
- (c) The Type 8 Safe Locker is 18-7/8 inches wide, 14-1/4 inches deep and 45 inches high and weighs 172 pounds when empty. The upper door, when opened, extends out approximately 12 inches. The lower door

is hinged about 2 inches above the base and, when opened, extends about 22 inches out from the front of the Locker.

(d) A lamp receptacle is provided in the upper compartment. Not less than a 25 watt lamp should be used, and it should be kept lighted at all times in order to keep the compartment free from moisture.

(e) Approximately ten feet of rubber covered cord is supplied with each Type 8 Safe Locker for connection to the ship's power supply. No terminal fitting is provided.

(f) Four 1/4" holes are prodded in the front door. The holes are properly spaced to fit the 1/4 inch bolt-holes which are provided in the base of the ECM.

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103. ARMY TYPE FIELD SAFE CH-76



(a) The Army Field Safe CH 76 is a semi-portable Field Safe designed for installation of the ECM. A limited number of these safes are available for use by naval holders at advanced bases. When used in the CH 76 Field Safe, the ECM must be installed in the special wooden box with which each safe is equipped. It is to be used by the U.S. Navy only under special circumstances, such as when the ECM is utilized ashore.

(b) The Field Safe CH-76 consists of two sections which are readily separated to facilitate carrying. Four handles are provided on each section. Each section weighs approximately 255 pounds when empty and is 31 inches long, 20-3/4 inches wide and 22 inches high. The ECM and the special wooden box weigh approximately 140 pounds, making a total weight, when completely assembled of approximately 650 pounds. Provision is made for holding two M-1 Thermite Bombs in position, ready for instant use. +

(c) Field Safes CH-76 are procured by request direct to the Commander of the Fleet under which operating.

104. UNCRATING AND CRATING

(a) The ECM Mark 2 Is normally shipped in a specially designed packing case. This case is then "floated" in excelsior in an outer box. The outer case may have been removed prior to delivery to the ultimate holder. Specific instructions for uncrating the ECM are given on the outside of each case as follows:

- (1) Set the Packing box on a bench in an upright position. The bottom of the box is the face containing four hexagon cap screws.
- (2) Remove fourteen brass screws from the lower edges of the box, thereby detaching it from the wooden base.
- (3) Lift the upper part of the box off the wooden base, taking care to lift vertically to avoid striking the machine.
- (4) Remove four hexagon cap screws from the underside of the wooden base, after which the machine can be removed.
- (5) Remove the twine holding the tape retainer and the power cord. Remove two wooden strips from between the base plate and the base casting.

(b) The special case should be preserved for future use. The ECM Mark 2 shall never be shipped or transferred without being properly crated.

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(c) On receipt of the Spare Parts Box, ENG 109, the spare parts should be checked against the "Check-off List", inspected, and if desired, re-packed.

105. SHIPPING DAMAGE

(a) When the ECM Mark 2 Is first uncrated it shall be immediately inspected for any damage that might have been caused in transportation. If damaged in shipment, a report shall immediately be made to the activity from which received. If the machine is damaged to the point where operation is not possible, the machine shall be transferred to the nearest ECM Repair Facility for repair. (See para. 501.)

106. INSPECTION

(a) To inspect the machine:

- (1) Remove the lid by lifting straight up.
- (2) Check the register number of the Cipher Unit and the machine against the transfer receipt.
- (3) Pull out the power cord and remove the paper covering.
- (4) Check the positions of the indicator plug and motor plug. For 110 volt operation they should be in the positions shown in Plate 8(b), with the pointer of the shorting plug pointing to 105-125. Check the marking of the motor plug, it must be AC for 110 volts alternating current (50 to 60 cycles) and DC for direct current.
- (5) Unscrew the fuse-holder caps and inspect the fuses. Five ampere fuses are ordinarily furnished, although some machines are equipped with 10 ampere fuses. (Spare fuses are in the Spare Parts Box.)
- (6) Check the pawl of the hand drive lever (See Plate 8(b)) to insure that the pawl rides in the channel ring.
- (7) Thread the paper tape. (See para. 406(c).)
- (8) Turn to Part III and follow instructions relative to operation.

107. ACCOUNTING

(a) Two sets of Code Wheels are normally issued with each ECM Mark 2, one for World Wide Crypto-Channels and the other for Area channels. Each holder is allowed a spare Cipher Unit (CSP 887). Spare Motors, spare Printers, Tender Repair Parts Kits, Repair and Maintenance Instructions and Blue Prints are issued only to ECM Repair Facilities.

(b) The following tabulation shows short titles, long titles and classifications of various units of the ECM.

SHORT TITLE	LONG TITLE	CLASSIFICATION
CSP 888	Electric Cipher Machine Mark 2 (without receptacles for parallel operation.)	Confidential
CSP 889	Electric Cipher Machine Mark 2 (with receptacles for parallel operation).	Confidential
CSP 887	Cipher Unit (Including Index Wheels).	Confidential
CSP (var)	Code Wheel Sets (Each set normally consists of ten Code Wheels).	Secret
CSP (var)	Key Lists	Secret

SHORT TITLE	LONG TITLE	CLASSIFICATION
ENG 106	115 volt, alternating current (50 to 60 cycles) Motor.	Unclassified
ENG 107	115 volt, direct current, Motor	Unclassified
ENG 108	Printer	Unclassified
ENG 109	Spare Parts Box	Unclassified
ENG 110	Tender Repair Parts Kit	Unclassified
ENG 111	Connecting Cable (for parallel operation).	Unclassified
ENG 112	Place Finder (discontinued, no longer available).	Unclassified
ENG 130	24 volt, direct current Motor	Unclassified
ENG 131	12 volt, direct current, Motor	Unclassified

108. STOWAGE OF CLASSIFIED PUBLICATIONS.

(a) RPS-4(A), paragraph 501, states:

(1) Stowage of SECRET and CONFIDENTIAL registered publications:

(A) Secret and Confidential registered publications will be stowed in the most secure space available, preferably a three-combination safe or vault. If a three-combination safe or vault is not available, then the publications should be kept constantly under armed guard.

(2) Stowage of non-registered publications:

(A) Secret and Confidential non-registered publications will be stowed in the most secure files available in a room that is kept locked when not in use.

(B) Restricted publications will be stowed and handled in such a manner as to insure a reasonable degree of security.

109. TRANSPORTATION.

(a) In accordance with the regulations set forth in the current edition of the Registered Publication Manual, (RPS-4), CSP's 888/889 and associated publications will, while being transported, invariably be accompanied by a commissioned officer.

110. COMPROMISE.

(a) RPS-4(A), paragraph 512 states:

(1) The importance of maintaining the contents of registered publications and devices "Secret" or "Confidential" as indicated on the publications cannot be too strongly emphasized. Should a Secret or Confidential publication or device be lost or compromised the fact shall be reported direct to the CNO **immediately** by dispatch, with the fleet, force, or shore based commander as an information addressee. Following this report, the commanding officer of the ship or station to whom the lost or compromised publication or device is charged shall conduct a thorough investigation in accordance with Article [76(7)] U.S. Navy Regulations, and he shall indicate in his report the action taken or recommended. The report of the investigation shall be forwarded to the CNO via the chain of command. In the case of Secret or Confidential publications or devices lost under circumstances which **preclude the possibility of compromise**, as by accidental burning or actual sinking in deep water, the direct immediate report is not required. The initial report in this case shall include the report of the investigation conducted by the commanding officer and shall be forwarded via the chain of command. In either case, the report of the investigation shall be submitted to the CNO (----- [Art. 76(7)(c)] -----, U.S. Navy Regs.) Upon receipt of a loss report by the CNO, if appropriate action has been taken by responsible commanders, the publication(s) lost will be removed from charge.

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(b) Any circumstances, such as safes being insecure, or having been left unlocked, or Secret or Confidential publications and devices having been left unguarded, which may in any way involve the compromise of such matter, shall be promptly reported to the CNO.

PROCEDURE FOR DESTRUCTION OF ELECTRIC

CIPHER MACHINE SYSTEMS

111. DESTRUCTION.

(a) Emergency destruction of the ECM and associated publications carried afloat is most readily accomplished by throwing them overboard in deep water. The water must be deep enough to insure that the machine and publications cannot be salvaged. Ashore, or in shallow water, the ECM and associated publications should be destroyed as described below.

112. ORDER OF DESTRUCTION.

(a) Destruction of electric cipher machine systems should be accomplished in the following order:

(1) Code Wheels

(2) Key Lists

(3) Machines

113. CODE WHEELS DESTRUCTION.

(a) Code Wheels should be destroyed in the order of greatest number distributed. (Class 3 World Wide, Class 3 Area, Class 4, etc.) Reserve-on-Board Code Wheels should be destroyed before effective Code Wheels.

(b) The wiring should be destroyed first:

(1) With a small torch unsolder the wires, and with a long nose pliers remove the wires from the Code Wheel. Cut the wires into small pieces and dispose of the pieces in any manner possible, compatible with circumstances and facilities available, which will prevent recovery.

(2) If a torch is not available, cut the wires as close as possible to the solder lug or pull the wires off. Dispose of the wires.

(c) In the case of the CCM Code Wheels, it is also extremely important to destroy the Code Wheels themselves, as well as the wiring, since the Code Wheels contain cam-contours.

(1) With a heavy hammer smash the Code Wheel faces into bits and dispose of the pieces to prevent recovery.

(d) If limitations of time or conditions of silence exist wherein the Code Wheels cannot be destroyed they should be disposed of in any manner possible which will at least delay recovery. If thrown overboard, they should be thrown singly in different directions.

114. KEY LISTS DESTRUCTION

(a) Key Lists should be destroyed in the order of greatest distribution (Class 3 World Wide, Class 3 Area, Class 4, etc.). Reserve-on-Board Key Lists should be destroyed before effective Key Lists.

(b) The preferred method of destruction is by burning, but care must be exercised to insure that every piece is burned and the ashes completely broken up to prevent reconstruction. Some Key Lists are printed on specially coated paper from which the printing will loosen upon immersion in water. This is an emergency provision only and such Key Lists should nevertheless be burned if time permits.

(c) If sufficient time is not available for burning, Key Lists should be thrown overboard in a perforated weighted bag.

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(d) Key Lists that cannot be burned or thrown overboard in a perforated weighted bag should at least be torn into bits and the pieces scattered.

115. MACHINES DESTRUCTION

(a) The most important cryptographic part of the ECM is the Cipher Unit and wiring which leads to it. The Zeroizer is next in importance, with the balance of the machine and wiring last.

(b) To destroy the ECM proceed in the following order:

(1) Remove the Cipher Unit from the machine, withdraw the Index Maze Spindle and remove the Index Wheels. Destroy the Index Wheels by smashing them with a heavy hammer. Cut the wires into pieces. Dispose of all parts in accordance with facilities available. Leave the Cipher Unit frame for destruction with individual parts of the machine.

(2) Remove the cover of the machine. (Two screws are located in front, one on each side, and one screw is located in the rear (inside)). Remove the protective plates on the left and right sides of the cipher unit frame. At this point time available determines the procedure.

(A) Unsolder all connections or cut the wires as close to the soldering lugs as possible.

(B) Cut the cables leading to the distributor plates as "straight across" as possible. (This is to prevent reconstruction by means of the color coding of the wires and may be omitted if time is sufficient to burn the entire machine.)

(C) Cut off the cable to the Zeroizer at the base and remove all wires from the Zeroizer.

(D) Destroy the ends of the cables thus cut, in any manner possible.

(3) With the Code Wheels and Key Lists destroyed and the Machine prepared as in the foregoing paragraphs, the main cryptographic features are destroyed - the rest of the machine (motor, printer, controller, keyboard, etc.) are items such as any Cipher Machine might contain. To make destruction complete smash all units (including the separators of the Cipher Unit) to destroy their usefulness. Cover with inflammable material and burn. Special attention should be taken to insure that the color coding of the wires is burned off and the wires broken.

(4) Dispose of all parts as best possible to preclude any recovery.

116. DEMOLITION CHARGES AND INCENDIARY BOMBS

(a) Demolition charges may be used for the destruction of the machine but should not be depended upon to destroy the Code Wheels. If it is intended to use a demolition charge for the destruction, the following items should be prepared as a destruction kit:

- (1) 2 one-half lb. standard TNT demolition charges.
- (2) 2 detonators for above, for electric firing.
- (3) 2 detonators for above, lighted fuse type.
- (4) 2 four-foot length, standard fuses (42 ft/mm.).
- (5) 1 exploder device with necessary wire for rigging.
- (6) Tools: Heavy hammer or axe; knife suitable for installing demolition charge, cutting wire, etc.; heavy metal plate, block or rock suitable for use in smashing Code Wheels with a hammer.

(b) One destruction kit should be provided for each machine and maintained for instant use. Exploders should be installed at a fixed remote location accessible for immediate use and wired to the location of machines. Detonators shall be stowed in destruction kit but shall be located in a safe place easily accessible to operating personnel.

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(c) To destroy the machine, remove CSP 887 (Cipher Unit) and install demolition charges In front left-hand corner of the cavity normally occupied by the Cipher Unit. Install the detonator and wiring or the fuse. Be sure that all personnel are clear before final connection of exploder is made or fuse Is lighted.

117. INCENDIARY BOMBS

(a) The M-1 Thermite Bomb is designed for emergency destruction of the ECM. Each bomb is packed in an individual container which weighs approximately 55 pounds. The container is 24 inches long, 20 Inches wide and 3-1/2 inches high.

(b) The M-1 Thermite Bombs are standard items in the U.S. Army as well as the U.S. Navy and carry the same designation in both services. They may be procured from Naval Ammunition Depots at certain locations, by request to the Fleet Commander who has directed distribution.

(c) To unpack the M-1 Bomb, remove one side of the wooden container. Remove the mounting brackets and mounting screws. Cut the moisture-proof paper wrapping and lift out the bomb.

CAUTION: In unpacking the bomb, care must be exercised that the bomb is not detonated by the accidental releasing of the firing ring of the manual detonator.

(d) Tape the firing ring of the manual detonator against the detonator.

(e) To prepare the ECM for destruction with the M-1 Thermite Bomb:

(1) Remove all Code Wheels from the ECM. Insert the Cipher Unit; the Index Wheels may remain In the Cipher Unit.

(2) Do not replace the lid.

(3) Place the Code Wheels on top of the machine in such a manner that they lie flat and as near the center of the machine as possible, but do not pile the Code Wheels on top of one another. Only one set of Code Wheels should be destroyed with the machine, but in case of emergency, Code Wheels may be piled one on top of another to a depth of three.

(4) Place the M-1 Bomb on top of the Code Wheels with approximately the same length of the bomb extending over each end of the machine.

(5) Detonate the bomb, either electrically or manually.

(f) To detonate the M-1 Bomb, electrically:

(1) Uncoil the wires, and twist together the bare ends of **ONE** wire from **each** pair of wires.

(2) Twist together, the bare ends of the other wires from each pair of wires.

(3) Stand to the side of the M-1 Bomb and touch the twisted ends to a source of voltage.

NOTE: Any voltage from a 1-1/2 volt flashlight up to a standard 110 volt lighting circuit may be used.

(g) To detonate the M-1 Bomb manually:

(1) Remove the tape holding the firing rings of the manual detonator in place.

(2) Stand to one side of the M-1 Bomb and pull the firing ring of the bomb.

(h) The M-1 Bomb does not explode, and a few seconds will elapse from the time the bomb is detonated until it is dangerous. If several bombs are to be detonated manually, start on one end and pull the firing rings in sequence.

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(i) Approximately two minutes are required for the bomb to "spend itself", but the machine will be left burning furiously.

(j) The M-1 Bomb is not recommended for destroying publications due to the difficulty in burning stacked sheets. Publications should be torn apart and each sheet crumpled before subjecting to fire.

MISCELLANEOUS

118. RETURN OF SUPERSEDED CODE WHEELS

(a) Sets of Code Wheels which have been superseded **and which have been specifically ordered returned in accordance with this paragraph** (or CSPM 374) should be prepared as followed:

(1) Cut or unsolder the wires from the solder lugs of all Code Wheels, being careful not to damage the Code Wheels or the solder-lugs. Destroy the wires or dispose of the pieces in accordance with facilities available.

(2) Remove the nameplate containing the CSP number and Register Number from the Code Wheel box, and place it in the box with the unwired Code Wheels. Suitably tag the box "RESTRICTED".

(3) Submit the usual Destruction Report.

(4) Transfer the Code Wheels to the nearest Issuing Office.

(b) Issuing Offices forwarded by ordinary mail or express to:

The Naval Code and Signal Laboratory
Communications Annex
Washington, 25, D.C.

(c) If facilities are available (such as ECM Repair Facility) Issuing Offices should prepare Code Wheels remaining in stock, as directed above; otherwise the Code Wheels must be returned by Officer Messenger.

119. REPORTS OF CASUALTIES AND DEFECTS.

(a) Whenever a ship or station is unable to use the ECM Mark 2 for its classified communication, because the machine is inoperative or because essential elements are lacking, that fact should be reported to the Chief of Naval Operations and to other superiors in the chain of command, as soon as practicable. The ship or station should also report when the ECM Mark 2 is again in operating condition. These reports need not be made by vessels having more than one ECM unless all are inoperative.

NOTE: This shall not be construed as authorizing violation of any condition of radio silence which may have been imposed by competent authority.

(b) The following guarantee is part of the contracts under which these machines were purchased:

"Contractor shall guarantee satisfactory performance for a period of one (1) year provided that such period shall not extend longer than two (2) years from date of delivery to the Navy. This guarantee shall include guarantee of all parts against defective design, material, or workmanship, and contractor shall agree to replace with satisfactory material any part found defective within the guarantee period, without cost to the Government."

In order to take advantage of this guarantee as well as to be informed of defective design or material as early as possible, it is essential that any defects be promptly reported on Bureau of Ships form NBS 383 by the activity effecting the repairs (normally an authorized ECM Repair Facility). The three white copies of NBS 383 should be sent to the Inspector of Naval Material, Chicago, Ill.; the yellow, green, and blue copies should be sent to the Bureau of Ships; and the salmon copy retained by the reporting activity. These reports should be marked "CONFIDENTIAL".

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120. STREAM-LINED INSTRUCTIONS.

(a) In writing these operating Instructions, an attempt has been made to make them as simple and as brief as possible. Information that is obvious has been omitted. Pictures and labels have been substituted for descriptions where practicable. The Parts List (with tracings, names, and part numbers) will be found in the Repair Instructions, furnished only to ECM Repair Faculties. Information necessary to the operation of the machine and not readily available to the holder has been included, insofar as service needs could be anticipated.

121. CRITICISMS OF ECM PUBLICATIONS. (a) It is requested that any comments, criticisms and suggestions in regard to these Operating Instructions, the Repair Instructions, or the various Key Lists be submitted to the Chief of Naval Operations. Such comments should be specific as to publication, page (or

paragraph) and subject matter. It is particularly important that any instructions that are not clear, too brief, or apparently lacking, be reported without delay in order that they may be incorporated in the superseding edition.

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Version 1.01, 23 May 05

PART II

DESCRIPTION

201. GENERAL

(a) The ECM Mark 2 is an electrically operated ciphering typewriter, assembled as one unit. The machine includes the following parts or features:

- (1) Code Wheels and Index Wheels
- (2) Cipher Unit
- (3) Code Wheel Stepping Assembly
- (4) Keyboard
- (5) Printer
- (6) Zeroizer
- (7) Controller
- (8) Electric Motor
- (9) Main-shaft
- (10) Emergency Hand Drive Lever
- (11) Automatic Word Spacer
- (12) Counter
- (13) Spark Suppressors
- (14) Input and Output Receptacles

202. CODE WHEELS AND INDEX WHEELS.

(a) Each Code Wheel consists of a steel ratchet, two face-plates and the wiring which connects the contacts of one face-plate to the contacts of the other face-plate.

(1) The 26 divisions of the steel ratchet serve a dual purpose - as a ratchet which the stepping pawl engages when the Code Wheel is stepped by the machine and as a detent for the detent rollers which hold the Code Wheel in definite positions. (2) Each face-plate contains 26 contacts. One of the face-plates has the letters of the alphabet engraved on its periphery for reference purposes in making Code Wheel Alignments. The other face-plate is engraved with the identifying number of the Code Wheel. Each face-plate has a projection (between "U" and "V" of the engraved face) called the cam-lobe. The cam-lobe stops the Code Wheel at "O" when zeroizing and controls the stepping of the Code Wheels of the Stepping Maze. (See paragraph 203(d)(2).)

NOTE: Certain Code Wheels designed for use with Adapters to be used in the ECM Mark 2 contain cam-contours (See paragraph 602) on the periphery of each face-plate. Technically, these may be called "detents" , but since a division of the steel ratchet is called a "detent", the designation "cam-contours" is used to differentiate between the two.

(b) The Index Wheels are similar to the Code Wheels but are smaller, containing ten contacts. An Index Wheel has no steel ratchet because it is not stepped by the machine; all setting must be done by hand. The Index Wheels are part of the Cipher Unit.

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203. CIPHER UNIT (CSP 887)

(a) The ciphering action of the ECM Mark 2 is produced by constantly interchanging the 26 alphabet circuits from the Keyboard to the Printer. When set for typing plain language, the machine is essentially an electric typewriter and will print the plain equivalent of the Keylever pressed because the circuits from the Keyboard are directly connected to the Printer. If, however, these circuits are interchanged or scrambled, the result will be a ciphering action. If the interchanged circuits are changed for each letter ciphered, the result will be a complex ciphering action. It is a function of the Code Wheels in the Alphabet Maze to produce the interchange of circuits, and the stepping of the Code Wheels constantly changes the ciphering action. When ciphering, the circuits from the Keyboard are connected through the Alphabet Maze Code Wheel circuits to the Printer.

(b) The Cipher Unit (CSP 887) is composed of six separators with through-contacts, detent rollers, spindles and Index Wheels. Two handles are provided to facilitate handling and four thumb-screws are provided for securing the Cipher Unit in place.

(1) The Cipher Unit contains, when the Code Wheels are inserted, all of the variable elements of the ciphering action. The removable feature of the Cipher Unit:

(A) Permits safe stowage of the cryptographic elements.

(B) Facilitates changing from one system to another when two Cipher Units are available.

(C) Facilitates emergency disposition overboard of the cryptographic elements.

NOTE: The ECM Mark 2, exclusive of the Code Wheels is classified CONFIDENTIAL. The Code Wheels are classified SECRET.

(c) The rear row of five Code Wheels and 26 associated circuits is called the ALPHABET MAZE. The 26 circuits from the Keyboard are connected through the Alphabet Maze to the Printer, but only one of the circuits is energized at a time. The function of the Alphabet Maze is to produce the ciphering action, which depends upon the arrangement and relative positions of the Code Wheels in the Alphabet Maze. During encipherment or decipherment, all five Code Wheels of the Alphabet Maze step in an erratic manner, in a ciphering cycle of substantially infinite length. IF, BECAUSE OF A FAILURE OF THE STEPPING CONTROL, THE CODE WHEELS DO NOT STEP, A SIMPLE SUBSTITUTION CIPHER RESULTS. (SEE PARA 203(f)).

(d)

(1) The front row of five Code Wheels (not the Index Wheels) and 26 associated circuits is called the STEPPING MAZE. Of the twenty-six circuits established only four are energized. The function of the Stepping Maze is to control in an irregular and erratic manner, the stepping of the Code Wheels in the Alphabet Maze.

(2) The automatic stepping of the Code Wheels in the Stepping Maze is controlled by the cam-lobes of the Code Wheels and the Zeroize contacts. The center Code Wheel steps once for each letter during the process of encipherment or decipherment. When the center Code Wheel is aligned to "O", the cam-lobe closes a contact and #4 Code Wheel (immediately to the right of the center Code Wheel) will step once on the next letter of the encipherment or decipherment. When both the center and #4 Code Wheels of the Stepping Maze are aligned to "O", #2 Code Wheel (immediately to the left of the center Code Wheel) will step once on the next letter of the encipherment or decipherment. The two end Code Wheels of the Stepping Maze are not automatically stepped during the process of encipherment or decipherment.

NOTE: If the cam-lobes are broken off or the contact springs are out of adjustment the machine will not function properly. When making the 26-30 Letter Check, the first cycle will cause the stepping of all three center Code Wheels (See paragraph 519).

(e) The front row of five Index Wheels is called the INDEX MAZE. Ten circuits are established, but only

four (and often only three, two or one) are energized. The function of the Index Maze is to establish stepping control circuits. The Index Maze selects five out of eleven possible stepping ratios and assigns them to the Code Wheels in any one of 120 possible different ways.

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(1) The four circuits of the Stepping Maze are connected through the Index Maze to the Code Wheel Stepping Magnets of the Alphabet Maze. IF, FOR ANY REASON, THE STEPPING CIRCUITS FAIL, THE CODE WHEELS OF THE ALPHABET MAZE WILL NOT STEP, AND A SIMPLE SUBSTITUTION CIPHER WILL RESULT. **AN INDEX WHEEL NOT ACCURATELY POSITIONED WILL PRODUCE THIS RESULT.**

(g) Cryptographically the Cipher Unit includes the. grouped-end contacts of the Stepping Maze and the Index Maze but physically these contacts are part of the frame of the machine.

204. CODE WHEEL STEPPING ASSEMBLY.

(a) The Code Wheels are stepped automatically by mechanical energy supplied from the main shaft through the stepping mechanism. The stepping bar assembly is moved back and forth once for each cycle. Stepping pawls are located on the stepping bars which, if unlatched will engage the ratchets of the Code Wheels. The Stepping Magnet associated with each pawl, will, when energized, unlatch the pawl, causing the Code Wheel to step. Only a momentary pulse of current through the Stepping Magnet is necessary to unlatch the pawl. The pawl is relatched by mechanical action after the Code Wheel is stepped.

NOTE: The relative position of the pawl and the ratchet is determined by the "fit" of the Cipher Unit. For this reason, the Cipher Unit should **always** be secured with the four thumb screws.

205. KEYBOARD.

(a) The Keyboard is similar to that of a typewriter, providing the alphabet letters, the numerals, dash (-) and space-bar. It has two extra Keys, the "Blank" which is used to step the machine through the ciphering action without printing on the tape and the "RPT" (Repeat) Key which is used to automatically repeat the action of any other Key.

NOTE: In using the "RPT" Key, it must be pressed **first** followed by the other Key.

(b) Each Keylever has an associated contact, which is closed by the action of depressing the Keylever. The contacts are located in the base of the machine and are made accessible for inspection, cleaning, adjustment, etc. by removing the base-plate of the machine. This is accomplished by setting the machine upright (using the back as a base support) and removing the two capscrews and the two countersunk nuts which secure the base plate to the machine. The contacts are mounted in two banks, each of which may be cast loose by removing the screws at each end of the bank.

(c) The first five numeral keylevers have two sets of associated contacts, the second of which is used only when the Code Wheels of the Stepping Maze are being aligned by these Keylevers.

(d) A universal bar extends beneath all the keylevers in such a manner that it is engaged and actuated by the depression of any individual keylever or the space-bar. A contact, operated by the universal bar and called the universal contact, prevents the machine from "repeating".

(e) Since the action of the keylevers depends upon the closing of electrical contacts rather than producing mechanical action, the "touch" of the Keyboard is necessarily different than that of an ordinary typewriter. It is essential that a positive "follow-through" rather than the "staccato touch" of the ordinary typewriter, be used. The machine will function reliably at a speed of 330 letters per minute provided a steady rhythmic typing is maintained. If this speed is exceeded or the typing speed is erratic, characters will drop out, and garbled or undecipherable text will result.

(f) The Keylever contacts are connected by the Controller to the Printer or Cipher Unit according to the operating process desired. Various positions of the Controller render certain Keys electrically inoperative.

206. **PRINTER.**

(a) The Printer prints the letters on the tape by mechanical energy supplied from the main shaft by the print hammer cam. The letter to be printed is selected electrically by the energizing of a Printer magnet.

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(b) The character is printed on the tape by the action of the print hammer striking the tape against the type wheel with the inked ribbon interleaved. The type wheel is held motionless during the printing through the action of the stop arm (attached to the type wheel) engaging one of the stop pins which are located about the printer shaft in such a manner that, when any one is unlatched, it will engage the stop arm. A stop pin is unlatched by the energizing of its associated magnet, and is relatched by the reset yoke after the letter is printed. A magnet is energized through the closing of a Keylever contact - for plain text the contact is connected directly to its respective magnet, for encipherment or decipherment the circuit is connected through the Alphabet Maze. A Printer magnet exerts a simple triggering action and a momentary surge of current is sufficient to unlatch the stop pin.

(c) In addition to the letter and numeral stop pins, two print suppression stop pins are provided to suppress printing when spacing between words, Zeroizing, making Code Wheel Alignments, etc. When the magnet of a print suppression stop pin is energized, the stop pin is unlatched and prevents the print hammer from striking the paper tape.

(d) The paper tape is advanced by the tape feed rollers which are turned by a friction clutch. The amount of feed is limited by the tape feed pawl and ratchet assembly which:

- (1) When deciphering or typing plain: advances the tape regularly, one space for each letter.
- (2) When enciphering: advances the tape regularly but in addition, adds an extra space every five letters to form five letter groups.
- (3) When resetting: prevents advancement of the tape.

(e) The paper tape may be manually advanced by pressing the tape release tab at the right of the tape channel. Printing which has not advanced far enough to clear the tape channel may be read by pressing the tape reading tab at the left of the tape channel.

(f) **The ribbon feed must be reversed by hand.**

207. **ZEROIZER.**

(a) The switch at the left, just above the Keyboard is called the Zeroizer. When set in the upper position, marked "Zeroize", the Code Wheels can be automatically aligned to "O". The Zeroizer is set in the lower position, marked "Operate", for all other operations.

208. **CONTROLLER.**

(a) The necessary electrical connections for the various operations of the machine are controlled by a multiple contact electrical switch called the "Controller".

(b) The Controller also controls, through a mechanical link, the spacing of the paper tape in accordance with the operation being performed.

(c) The five settings of the Controller and corresponding effect on the operation of the machine are as follows:

- (1) "O" (Off) position: The power switch is turned off.
- (2) "P" (Plain) position: The Printer prints plain text, exactly as typed, including numerals, dash and spacebar. The circuits to the Stepping Magnets are opened and the Code Wheels do not step. The paper tape is advanced regularly.
- (3) "R" (Reset) position: There is no printing on the tape and the paper tape feed is suppressed.

(A) Zeroizer at "Zeroize". Only the Blank and RPT Keys are operative. This position is used to zeroize the Code Wheels.

(B) Zeroizer at "Operate". The keylevers "1" to "5" are operative. This position is used to make a Code Wheel Alignment.

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(4) "E" (Encipher) position. The alphabet, Blank and RPT keylevers and space bar are operative. Numeral and (-) keylevers are inoperative. Letters pressed on the keylevers are enciphered and the resultant cipher equivalents are printed on the tape in groups of five letters. Pressing the space bar results in the printing of a cipher equivalent on the tape. The Code Wheels step with each letter or space enciphered, thus constantly changing the ciphering process.

(5) "D" (Decipher) position: The alphabet, Blank and RPT keylevers are operative. Numeral and dash (-) keylevers and space bar are inoperative. Letters pressed on the keylevers are deciphered and the resultant plain equivalents are printed on the tape with word spacing the same as during encipherment. The Code Wheels step with each letter deciphered, to correspond to the stepping during the encipherment.

209. ELECTRIC MOTOR.

(a) The following standard types of motors are available:

Voltage	Cycles	Type	H.P.	RPM	ModelNo.	ENG
115*	60**	AC Induction	1/40	1725	S-9037	106
115*		DC Compound	1/40	1725	S-9038	107
24#		DC Shunt	1/40	1725	S-9045-JU	130
12#		DC Shunt	1/40	1725	S-9055-JU	131

* These motors are interchangeable in any machine. The AC Motor Plug and the DC Motor Plug are wired differently, the connections being so arranged that when a particular plug is inserted, proper current-limiting resistors are connected into the circuits for correct operation on that type current.

** Will also satisfactorily operate on 50 cycles with slight reduction in speed.

These motors require special connections They are available only by special request to CNO and for special applications only.

(b) The motor drives the main shaft through a gear a pinion and magnet operated clutch. The motor is

mounted on a tilting mounting base which permits adjustment 1 the mesh of the motor pinion and main shaft drive gear by means of the adjusting screw. Since the oil is apt to swell the fiber gear, this adjustment should be checked at frequent intervals especially alter the machine has been idle for a protracted period. (See paragraph 515.)

210. MAIN SHAFT.

(a) The mechanical power of the electric motor is transmitted to the various units of the machine by means of the main shaft. In the normal unoperated position, the motor does not turn the main shaft because the clutch driven member is held out of mesh with the clutch drive member by the clutch throwout lever. When the clutch magnet is energized, the clutch throwout lever releases, permitting the gears to mesh. At the conclusion of the cycle, the driven member is again thrown out of mesh, stopping the main shaft. The main shaft turns only immediately after the depression of a key and makes one revolution for each cycle.

(b) The main shaft provides a timing control as well as the transmission of power.

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(c) The following parts are mounted on the main shaft in the following order from left to right:

- (1) Channel cam
- (2) Printer reset cam
- (3) Printer drive gear
- (4) Timing cam (printing)
- (5) Timing cam (stepping)
- (6) Print hammer cam
- (7) Tape feed cam
- (8) Counter operating cam
- (9) Tape feed drive gear
- (10) Math-shaft drive gear
- (11) Clutch drive member

(12) Clutch driven member

(13) Hand lever pinion.

(d) The cycle of events occurring when a key is depressed during encipherment or decipherment is as follows:

(1) The keylever contact closes the circuit to a Printer magnet, through the common side of the printer magnets, through the Printing Contact (which is closed) through the clutch operating magnet, completing the circuit. The Printer magnet is thus energized simultaneously with the clutch trip magnet before the main shaft has commenced to turn.

(2) Depressing the keylever also closes the universal contact keeping a potential on the clutch operating magnet, which prevents the clutch from repeating its operation until the universal contact is opened by releasing the keylever. This prevents the machine from repeating. Closing the "Blank" keylever contact also energizes the clutch operating magnet, and in addition energizes a print suppression magnet which prevents the print hammer from striking the tape.

(3) The clutch operating magnet, when energized, trips the clutch and starts the main shaft turning. Upon turning approximately 1/20 of one turn, the printing contact opens, and the stepping contact closes permitting a pulse of current to flow through the stepping magnets.

(4) The Stepping Contact also closes the circuit to the stepping magnet of the center Code Wheel of the Stepping Maze (and possibly to one or both stepping magnets of the adjacent Code Wheels).

(5) When the main shaft has turned approximately one-tenth of a turn, the stepping contact opens. All electrical functions have been completed at this time, the following functions being mechanical and completed by the main shaft turning the remainder of the turn (cycle):

(A) The Printer drive gear turns the Printer typewheel. The Print hammer cam releases the print hammer which strikes the paper tape and prints the character. The Printer reset cam relatches the pin, completing this cycle. Also as a last step of the cycle, the tape feed cam functions, advancing the tape.

(B) The Counter cam imparts motion to the counter operating arm, advancing it one number.

(C) The Code Wheel Stepping cam moves the stepping drive bar assembly towards the front of the machine engaging the pawls which have been unlatched, to the steel ratchet of the corresponding Code Wheels, advancing the Code Wheels one letter. During the last one-fourth turn of the main shaft, the Code Wheel stepping cam retracts the drive bar assembly by quick return action. At its farthest retracted point, the pawls are relatched, then the assembly advances about 1/8 " to clear the pawls at which time the main shaft drive clutch disengages and the stepping assembly is ready for the next ciphering cycle.

(D) At the conclusion of the cycle, the clutch members are disengaged automatically, and are locked into the un-meshed position. The clutch may be tripped in two ways:

(1) Through the energizing of the Clutch Magnet, which operates through a triggering action.

(2) By reaching inside the case, and pressing down on the clutch throwout lever extension. This lever is located In front of, and nearly under the frame of the motor. This is done for inspection and test only.

(e) It is important to note that the machine first enciphers the character, then advances the Code Wheels to their next position, and finally prints the character as one of the last operations of the cycle. The Code Wheels are at rest while the circuit through them is energized; no current is broken at the Code Wheel contacts.

211. EMERGENCY HAND DRIVE.

(a) The emergency hand drive is provided as a means of manually supplying the mechanical power for operation of the machine in case of failure of the regular power supply.

(b) The energy of the hand drive lever is transmitted to the main shaft through a pawl and ratchet. In normal operation, the pawl is withheld from the ratchet by a channel ring. When using the hand drive lever, the channel ring is slid to the outside, permitting the pawl to engage the ratchet.

NOTE: IT IS IMPORTANT THAT THE PAWL BE CARRIED IN THE CHANNEL RING DURING NORMAL OPERATION.

(c) When properly adjusted for normal operation the hand drive lever is free to move up and down without effect on the main shaft. If improperly adjusted, normal operation will needlessly wear out the pawl and ratchet, produce excessive noise and, of prime importance, be a potential source of damage to the machine.

(d) When using the hand drive lever, electric power for operation at the Printer and Stepping Magnets may be supplied from any source capable of producing 24 volts D.C. The current drain is quite small and a battery of flash light cells may be used for this purpose. Tests have shown that 18 flashlight cells in series will actuate the machine 200,000 times without exhausting the battery. A standard 22-1/2 volt (or one section of a 45 volt) Radio "B" Battery will provide a satisfactory source of power.

NOTE: The machine will operate satisfactorily on any voltage from 20 to 28 volts. Voltages less than 18 volts will not produce satisfactory results, and voltages in excess of 30 volts are dangerous to the machine.

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212. AUTOMATIC WORD SPACER.

(a) The ECM Mark 2 is so designed that it is possible to encipher "spaces" with the result that the words of the decipherment are normally spaced. This is accomplished as follows:

(1) When the Controller is set at "E" (Encipher), the "Z" keylever contact is paralleled with the "X" keylever contact, and the space bar contact is connected to the "Z" circuit. The "Z" is thus enciphered the same as an "X".

(2) When the Controller is set at "D" (Decipher) the "Z" printer circuit is connected to a print suppressor magnet.

(b) Deciphered words will appear with normal spacing as enciphered, but words containing the letter "Z" will be spelled with an "X" instead of a "Z". Example: XERO, XE BRA, etc.

213. COUNTER.

(a) A mechanical counter, indicating from 0000 to 9999 is provided for convenience in counting the number of letters. It is driven by a cam on the cam-shaft. **It must be reset by hand.**

214. SPARK SUPPRESSORS. (See Plate 7)

(a) The ECM Mark 2 generates a reaction voltage of approximately 750 volts which would short circuit or burn out the Code Wheels, pit contact points, interfere with radio reception, and be otherwise detrimental if it were not dissipated by the spark suppressors.

(b) The failure of spark suppressors may not immediately render the machine inoperative or be immediately apparent, for this reason all elements of the spark suppression circuits should be periodically checked.

(c) Sparking at the Stepping or Printing Contacts is a danger signal. Only a very small spark should be

visible when the machine is operating on direct current. When the machine is operated on alternating current, the sparking at the contacts is a little more visible, but the spark is not a healthy spark capable of much damage. Whenever the failure of the spark suppressors is suspected, the machine should be checked at once for a shorted capacitor or burned out resistor. Spare resistors and capacitors are furnished in the Spare Parts Box. (See paragraph 513.)

215. INPUT AND OUTPUT RECEPTACLES.

(a) CSP 889 contains, in the base at the rear, two multiple connector receptacles, one designated "OUTPUT" and the other designated "INPUT". By the use of the connecting cables (ENG 111) the output of one machine may be delivered to a second machine so that, as text is enciphered on the master machine, the enciphered text is deciphered on the second machine, affording an instantaneous check on the encipherment.

(b) The use of the External Connector Receptacles is recommended only when a skilled typist with a smooth rhythmic touch is to operate the machine. (See paragraph 322).

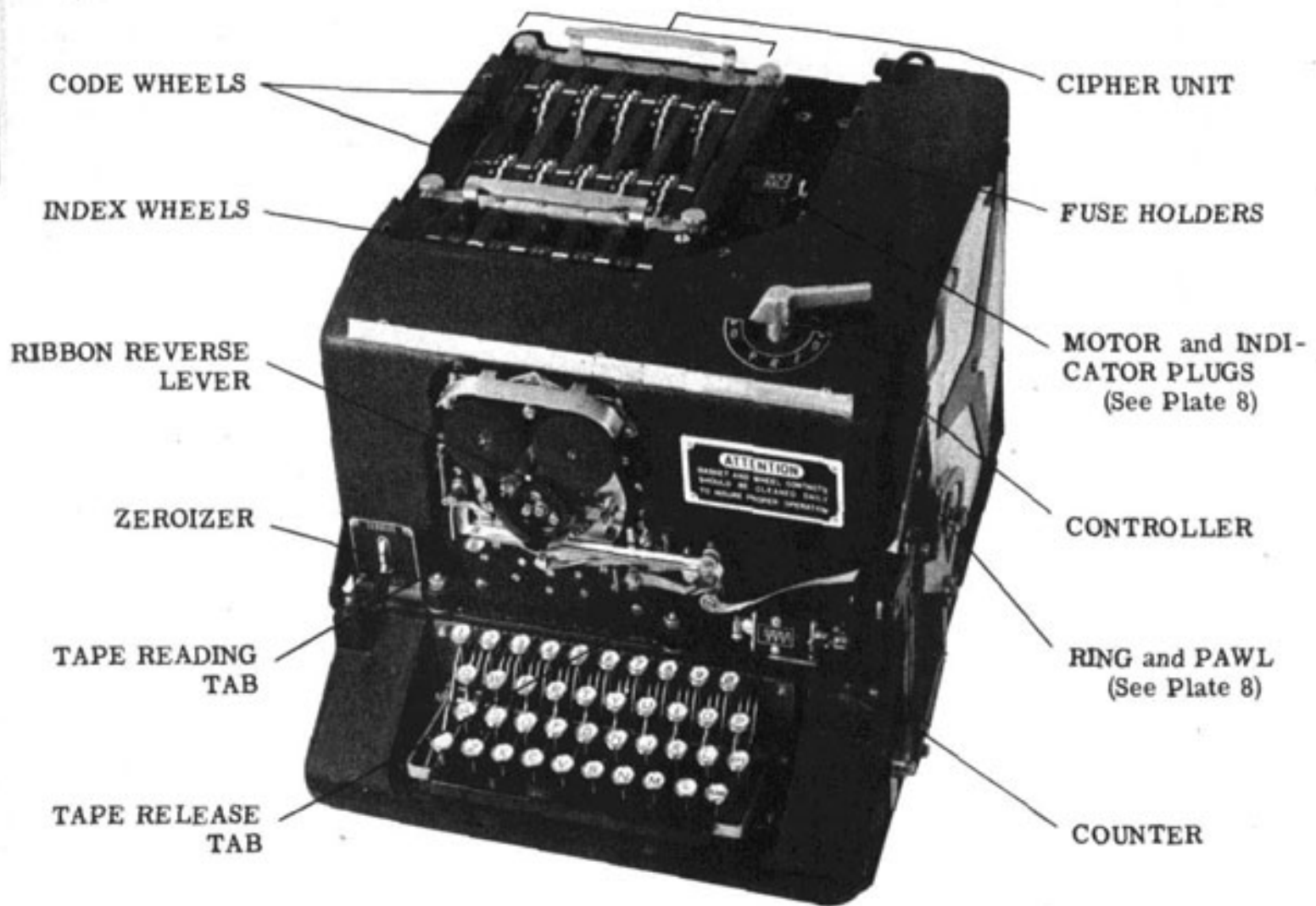


PLATE 2

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Version 1.01, 23 May 05

PART III

OPERATION

301. REQUIREMENTS.

(a) The following are required for operation of the ECM Mark 2:

- (1) CSP 889 (or 888) complete, in operating condition.
- (2) The effective Key List.
- (3) The set of Code Wheels upon which the Key List is based.

302. PREPARATION OF MACHINE. (a) Prepare the machine for operation in accordance with paragraph 106.

- (1) Insure the motor plug and indicator plug are in the proper receptacles as shown in Plate 8.
- (2) For motor operation, insure the pawl of the emergency hand drive gear rides in the channel ring (See Plate 8).
- (3) Insure the power cord is plugged into the proper source of power for the type of motor installed in the machine.
- (4) The ground connection clip of the power cord should be connected to the metal of the Type 8 Safe Locker or to the ship's structure. This suppresses radio-interference; no difference in the operation of the ECM may be noticed.

303. KEY LIST.

(a) The effective edition of the Key List is determined by associated communication publications: Crypto-Channel Charts, CSPMs, etc.

(b) Each ECM Mark 2 Key Setting contains:

(1) The Code Wheel Arrangement.

(2) The Index Setting(s) and corresponding 26-30 Letter Check.

(3) Certain types of Key Lists may, in addition, contain one or more Initial Code Wheel Alignments.

(c) The following illustration is an example of the Key Setting Form most generally used. It Is based on CSP 1336.

Code Wheel)	Alphabet Maze:-----	Al:	38R	33	35	37R	36	
Arrangement)	Stepping Maze:-----	St:	32R	34	39R	31	40	
Index)	for SECRET messages:-----	SEC:	13-27-36-42-53	C	F	A	N	B
Wheel)	for CONFIDENTIAL messages:-----	CON:	10-27-34-41-50	H	T	E	W	B
Settings)	for RESTRICTED messages:---	RES:	19-28-37-40-58	L	O	W	Y	C

(d) The Code Wheel Arrangement consists of ten numbers corresponding to the numbers engraved on the Code Wheels. The Key List omits any letter prefixes or suffixes of the individual Code Wheel designations and in some Key Lists only the final digit may be shown.

(1) (A) The Code Wheels corresponding to the first group of five numbers listed (generally designated "AL:") are to be Inserted in the Alphabet Maze (the rear row) In order from left to right, as appearing in the Key List.

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(B) The Code Wheels corresponding to second group d five numbers listed designated "ST:") are to be inserted in the Stepping Maze (the middle row) in order from left to right, as appearing in the Key List.

(2) The letter "R" (reverse) appearing after a Code Wheel number in the Key List indicates that that particular Code Wheel is to be inserted in the reversed position (i.e., with the engraved alphabet letters appearing upside down to the operator).

(e) (1) The Index Wheels are normally not removed from the Cipher Unit, and their arrangement normally remains the same. Certain Key Lists, however, may call for a different Index Wheel Arrangement, in which case the Index Wheel spindle is removed and the Wheels rearranged in accordance with the "tens" digits d the Index Wheel Arrangement.

(2) Different Index Wheel Settings are given, corresponding to the different secrecy classifications of the messages for which the Key List was designed. Normally there are three Index Settings, one each for SECRET, CONFIDENTIAL and RESTRICTED messages, respectively.

(3) The five letter group following each index Setting is the corresponding 26-30 Letter Check. The five letter group is the encipherment of the letter "A" on the 26th to 30th steps inclusive from the Zeroize position using the Code Wheel Arrangement and the Index Wheel Setting given in the Key. **THE 26-30 LETTER CHECK SHALL BE MADE EACH TIME CSP 887 IS INSERTED IN THE MACHINE AND AFTER EACH CHANGE OF CODE WHEEL ARRANGEMENT OR INDEX WHEEL SETTING. ITS USE IS MANDATORY.**

304. CODE WHEEL SET.

(a) The set of Code Wheels upon which the Key List is based is shown in the Instructions appearing in the Key List, generally in paragraph 1. A Key List is said to be based upon a particular set of Code Wheels because that particular set was used to obtain the 26-30 Letter Check(s) given in the Key Setting.

305. CODE WHEEL ARRANGEMENT.

(a) To make the Code Wheel Arrangement:

(1) Remove the lid from the cover by lifting straight up.

(2) Loosen the four thumb-screws which secure the Cipher Unit (CSP 887) and remove the Cipher Unit by lifting it straight up from the machine.

CAUTION: Use **BOTH HANDS** in removing and inserting the Cipher Unit.

(3) Remove the Code Wheel spindles, Insert the Code Wheels in the Cipher Unit in the arrangement and positions shown by the Key. Insert the Code Wheel spindles.

(4) Carefully insert the Cipher Unit into the machine and secure it by means of the four thumb screws.

CAUTION: Use **BOTH HANDS** in removing and inserting the Cipher Unit.

306. INDEX WHEEL SETTING.

(a) Rotate, by hand, the Index Wheels until they are set at the positions given in the Key List. The Index

Wheels are not moved mechanically and are not to be moved again during the course of enciphering (or deciphering) the particular message.

(b) BE SURE THE INDEX WHEELS ARE IN **EXACT** ALIGNMENT.

(c) Replace the lid.

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307. **ZEROIZING.**

(a) The process of turning the Code Wheels so that each one is set with the letter "O" opposite the white reference lines is called "Zeroizing", and when the Code Wheels are all set, it is called the "Zeroize position". All processes (except special methods of operation) start from the Zeroize position.

(b) To Zeroize:

(1) Set the Controller at "R" (Reset). The motor should start as soon as the Controller is turned away from "O" (OFF).

(2) Set the Zeroizer (the "up and down" switch at the front left) at "Zeroize".

(3) Press the "RPT" Key, then the "Blank" Key and hold both keys down. The Code Wheels will step until each Code Wheel has reached its zeroize position (i.e., with the letter "O" opposite the white reference line) where it will stop.

NOTE: If each Code Wheel does not step and automatically stop at its zeroize position, the cause should be ascertained and corrected. See paragraph 506.

(4) When all Code Wheels have stopped at the Zeroize position release the Blank and Repeat Keys.

308. **26-30 LETTER CHECK.**

(a) The 26-30 Letter Check is given as a method 1 checking:

(1) That the machine is operating properly.

(2) That the Code Wheel Arrangement is correct.

(3) That the Index Setting is correct.

(b) A correct check assures the operator that the machine is in initially good operating condition. It does not insure that the machine will continue to function perfectly beyond the 30th step, but failure beyond this point is not likely to occur.

NOTE: Periodic checks for steps up to 10,000 are given in paragraph 519.

(c) To make the 26-30 Letter Check.

(1) Make the Code Wheel Arrangement and Index Setting in accordance with the Key Setting.

(2) Zeroize.

(3) Set the Zeroizer at "Operate", and set the Controller at "E" (Encipher). Reset the counter to zero.

(4) Press the "Repeat" Key, then the "Blank" Key, and hold both Keys down until the counter approaches twenty-five. Release both Keys, and, by means at the "Blank" Key, step the Code Wheels until the counter reads twenty-five.

(5) Press (Encipher) the letter "A" five times.

(6) The printed encipherment of "A" should check with the values given in the Key List.

(d) Failure to produce the 26-30 Letter Check may indicate:

(1) An incorrect set of Code Wheels or an error in the Code Wheel Arrangement.

(2) An error in the Setting (or Arrangement) of the Index Wheels.

NOTE: If an Index Wheel is improperly positioned (i.e. set "half-way") the resultant 26-30 Letter Check will consist of five alike letters).

(3) The machine is not functioning properly. (The most common fault is dirty contacts of the Code Wheels or Cipher Unit. (See paragraph 403.)

(4) An error In the 26-30 Letter Check given in the Key List. Every precaution is taken to insure that the correct value is given, however, a simple typographical error in the Code Wheel Arrangement will give an entirely different 26-30 Letter Check. An error in an Index Setting will give an erroneous check for that Setting. Four correct letters should be accepted. If the 26-30 Letter Check is not obtained, it should be attempted on a second machine or with other Code Wheels if these are available. Code Wheel and Cipher Unit contacts should be cleaned (see paragraph 403). If the 26-30 Letter Check cannot be obtained, and the operator is satisfied that everything is functioning correctly, the 26-30 Letter Check as appearing in the Key List should be ignored. However, **under no condition will the machine be used if the 26-30 Letter Check so obtained is five alike letters.** (See paragraphs 328 and 511).

(e) THE 26-30 LETTER CHECK SHALL BE MADE EACH TIME CSP 887 IS INSERTED IN THE MACHINE AND AFTER EACH CHANGE OF CODE WHEEL ARRANGEMENT OR INDEX SETTING. **ITS USE IS MANDATORY**

309. CODE WHEEL ALIGNMENT.

(a) The Code Wheel Alignment is a group of five letters, selected at random, to which the Code Wheels of the Stepping Maze (the front row of five Code Wheels) are set prior to encipherment (or decipherment).

(b) This alignment (or reading) of the Code Wheels of the Stepping Maze at the start of the actual encipherment is transmitted unenciphered as the INTERNAL INDICATOR of the message. It shall be recorded on the message being enciphered for reference purposes in case a verification is requested.

CAUTION: THE CODE WHEEL ALIGNMENT FOR EACH MESSAGE ENCIPHERED BY A PARTICULAR KEY SETTING MUST BE DIFFERENT. THE SELECTION OF THE LETTERS MUST BE ENTIRELY AT RANDOM, THE LETTERS "O" AND "Z" MUST NOT BE USED, AND THE LETTERS MUST NOT FOLLOW A REGULAR SYSTEM OF PROGRESSION. (See paragraph 329).

(c) To make the Code Wheel alignment:

(1) Zeroize the Code Wheels, (pan. 307). Set the Controller at "R" (Reset) and the Zeroizer at "Operate". The left (#1) Code Wheel of the Stepping Maze will step one letter for each time the numeral "1" Key is pressed. Press and release this Key the number of times required to align #1 Code Wheel to the first letter of the Code Wheel Alignment.

NOTE: While the Code Wheels of the Stepping Maze are being aligned, the Code Wheels, of the Alphabet Maze will also step.

(2) Similarly align, in succession, the second (#2) Code Wheel with the numeral "2" key, the third (#3) Code Wheel with the numeral "3" key, etc, until the Code Wheels of the Stepping Maze are aligned to the letters chosen.

CAUTION: The Code Wheels must be aligned in correct sequence. If any Code Wheel is stepped past the correct letter or if the Code Wheels are not set in proper sequence, the entire process must be re-commenced from the zeroize position.

(3) Do not use the Repeat Key in this operation, and avoid a "staccato" touch of the numeral Keys. It is possible to press the Key and release it quickly enough that the Code Wheels of the Stepping Maze will step, but the Code Wheels of the Alphabet Maze will not, thus resulting in an incorrect setting.

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(4) After the Code Wheels of the Stepping Maze have been set to the Code Wheel Alignment, **CHECK THE ALIGNMENT OF THE CODE WHEELS OF THE ALPHABET MAZE TO INSURE THAT ALL FIVE OF THESE WHEELS ARE NOT ALIGNED TO "O"**.

While the Code Wheels of the Stepping Maze are being aligned, the Code Wheels of the Alphabet Maze should step in an irregular manner. If for any reason they do not step, this will be indicated by the fact that all five Code Wheels of the Alphabet Maze will remain aligned to "O". Therefore, if **all five** of these Code Wheels are found on "O" after the Code Wheel Alignment has been made, the machine is not functioning properly. In this case, **make the 26-30 check** and follow instructions in paragraph 308.

(d) Certain methods of operation require manual alignment of the Code Wheels. When this Is required, follow Instructions appearing in the Key List.

310. HEADINGS AND INDICATORS.

(a) To type the Heading and Indicators alter having set-up the Code Wheel Alignment:

- (1) Set the Controller to "P" (Plain) and the Zeroizer to "Operate".
- (2) Type the heading, date/time group and any other identification data desired.
- (3) Advance the tape by means of the space bar, or press the tape release tab and pull the tape two or three inches.
- (4) Type the External Indicator. The External Indicator is given in the Key List, Rotating Indicator List, Crypto-Channel Charts, etc. Many of the crypto-channels In which the ECM is used have been assigned several Rotating Indicators for each classification. It is important that these Indicators be used equally and in random order, and checked off as used so that an Indicator will not be used again until all the others have been employed, and so that an alphabetical or other pattern will not be apparent.
- (5) Space once and type the Internal Indicator (the letters chosen for the Code Wheel Alignment see paragraph 309(a)). Space once.
- (6) Reset the Counter to zero.

NOTE: Certain Operators may prefer to type the Heading, Indicators, etc. before aligning the Code Wheels. In this case, perform the operations of this paragraph before those of paragraph 309.

PROCESS TO BE FOLLOWED FOR ENCIPHERMENT ONLY. -

311. ENCIPHERMENT.

- (a) Having aligned the Code Wheels, typed the Heading, External and Internal Indicators, etc:

- (1) Set the Controller to "E" (Encipher) and the Zeroizer to "Operate". Reset the Counter to Zero.
- (2) Type the text to be enciphered, using the space bar and alphabet keys only. Spell out numerals. The letter "X" shall normally be used to represent every mark of punctuation. When necessary for clarity, punctuation marks may be spelled out. The only abbreviations for punctuation authorized are PAREN, PARA, and QUES. All punctuation shall be kept at a minimum and used only when necessary to attain clearness. The enciphered text will appear on the tape In groups of five letters When padding is added at either or both ends to conceal a particularly short message, one in stereotyped form, or one which has been or may be encrypted in another system, the use of spaces and other stereotyped padding must be avoided. (See Chapter IV, **Communication Instructions** for example of objectionable padding.)

312. COMPLETING THE MESSAGE.

(a) Set the Controller to "P" (Plain). Leave the Zeroizer at "Operate".

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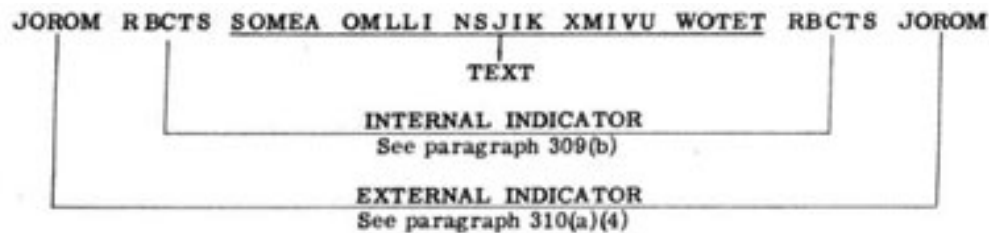
(b) Note the Counter reading and if necessary, type the letter "X" as many times as required to produce a counter reading which is a multiple of five. Space once.

(c) Type the Internal Indicator, space once and type the External Indicator.

(d) Advance the tape until all printing is clear of the guide and tear off the tape. The tape is now ready for pasting on the message blank.

313. EXAMPLE.

(a) The following example illustrates the appearance of a message enciphered in this manner. It is based on the sample Key Setting shown in paragraph 303(c). JOROM is assumed to be the CONFIDENTIAL External Indicator.

**314. CHECK DECIPHERMENT.**

(a) As a check on accuracy, an enciphered message shall be check-deciphered prior to transmission, preferably by another coding officer, and if possible, on a second machine using a different set of Code Wheels. In an emergency the check-decipherment may be deferred until after transmission, but should be completed as soon as possible. THE CHECK-DECIPHERMENT IS MANDATORY.

PROCESSES COMMON TO DECIPHERMENT ONLY**315. DECIPHERMENT.**

(a) To prepare the machine for deciphering a message:

(1) Insert the Code Wheels in accordance with the Code Wheel Arrangement appearing in the Key List.

(2) Set the Index Wheels in accordance with the Index Setting in the Key List which corresponds to the secrecy classification of the message as determined by the External Indicator of the Message.

(3) Make the 26-30 Letter Check.

(b) To decipher the message:

(1) Zeroize.

(2) Set the Zeroizer at "Operate", leave the Controller at "R" (Reset).

(3) Align the #1 (left) Code Wheel of the Stepping Maze to the first letter of the Internal Indicator of the message by pressing and releasing the numeral "1" Key. Similarly, align #2 Code Wheel to the second letter of the Internal Indicator by means of the numeral "2" Key, etc., until all five Code Wheels of the Stepping Maze have been aligned to the letters of the Internal Indicator.

(4) Set the Controller at "D" (Decipher), leaving the Zeroizer at "Operate". Reset the Counter to zero.

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(5) Type the text to be deciphered, ignoring spacing between groups. The space bar is inoperative while the Controller is set at "D" . The Plain text will appear with normal spacing between words, except that "X" will be printed where "Z" would normally appear - **XERO**, **XEBRA**, **RENDEXVOUS** etc.

(6) Upon completion of the decipherment advance the tape until the printing is clear of the tape channel and tear off the tape.

JOINT ARMY-NAVY METHOD OF OPERATION OF THE ECM

316. GENERAL.

(a) The U.S. Army general method of operation of the ECM differs from the method in general use by the U.S. Navy in that:

- (1) The Code Wheels are aligned by hand.
 - (2) The Code Wheels of the Alphabet Maze are aligned to the Code Wheel Alignment as well as the Code Wheels of the Stepping Maze.
 - (3) The Code Wheel Alignment is enciphered, by means of an additional element of the Key Setting before it is included in the message as the Internal Indicator.
- (b) The U.S. Army method of operation is used in Joint Army-Navy ECM systems.

317. KEY LISTS.

- (a) The following illustration is an example of the Key Setting Form most generally used in Joint Army-Navy Key Lists. It is based on CSP 1336.

Code Wheel)	Alphabet Maze: -----	Cip/Alp: 31 40 32R 39 37
Arrangement)	Stepping Maze: -----	Con/Stp: 34 36R 35 38R 33
Index Wheel)	for SECRET messages: -----	SEC 15-24-33-41-58 GDOZZ
Settings)	for CONFIDENTIAL messages: ..	CON 10-21-32-42-54 IFEKA
Initial Code Wheel Alignment: - - - - -		Initial Alignment: N R S U W

- (b) The sample Key List illustrated provides for both SECRET and CONFIDENTIAL messages. The Key Setting consists of:

- (1) The arrangement of the Code Wheels in the Alphabet Maze (U.S. Army: Cipher Rotors) designated "Cip/Alp:".
- (2) The arrangement of the Code Wheels in the Stepping Maze (U.S. Army: Control Rotors) designated Con/Stp: -
- (3) The setting of the Index Wheels (U.S. Army: Index Rotors) for SECRET messages designated "SEC" and corresponding 26-30 Letter Check.
- (4) The setting of the Index Wheels (U.S. Army: Index Rotors) for CONFIDENTIAL messages, designated "CON" and corresponding 26-30 Letter Check.
- (5) The Alignment of the Code Wheels which is initially used in the process of encipherment, called the Initial Code Wheel Alignment (U.S. Army: Initial Alignment) designated "Initial Alignment".

- (c) The use of the 26-30 Letter Check is not mandatory in the U.S. Army. When given in the Key List, the use of the 26-30 Letter Check **is** mandatory In the U.S. Navy regardless of the particular Key List in use.

The 26-30 Letter Check Is made in the same manner as in the standard U.S Navy general method of operation.

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318. DEFINITIONS.

(a) In this method of operation, two different Code Wheel Alignments are used, requiring differentiation:

(1) The **MESSAGE CODE WHEEL ALIGNMENT** Is the alignment appearing upon the Code Wheels at the start of the actual encipherment of the message. It consists of five letters selected at random.

(2) The **INITIAL CODE WHEEL ALIGNMENT** is the alignment given in the Key List and is used in the process of enciphering the Message Code Wheel Alignment.

(b) The **INTERNAL INDICATOR** Is the encipherment of the Message Code Wheel Alignment, using the Initial Code Wheel Alignment at the beginning of the encipherment.

(c) The **EXTERNAL INDICATOR** is provided for by each Key List.

319. ENCIPHERMENT.

(a) Arrange the Code Wheels in accordance with the Key List and set the Index Wheels to the Setting corresponding to the classification of the message.

(b) Make the 26-30 Letter Check.

(c) Set the Controller to "P" (Plain) and set the Zeroizer to "Operate". Type the Heading, Date/Time Group and any identification data desired. Type the **EXTERNAL INDICATOR** and space once.

(d) Set the Controller to "E" (Encipher). Align, by hand **both** the Code Wheels of the Alphabet Maze **and** the Code Wheels of the Stepping Maze to the **INITIAL CODE WHEEL ALIGNMENT** given in the Key.

(e) Select at random a group of five letters to use as the **MESSAGE CODE WHEEL ALIGNMENT**. Make a note of the five letter group on the message being enciphered for reference purposes in case a verification is requested.

CAUTION: THE MESSAGE CODE WHEEL ALIGNMENT FOR EACH MESSAGE ENCIPHERED BY A PARTICULAR KEY SETTING MUST BE DIFFERENT. THE SELECTION OF THE LETTERS MUST BE ENTIRELY AT RANDOM, THE LETTERS "O" AND "Z" MUST NOT BE USED, AND THE LETTERS MUST NOT FOLLOW A REGULAR SYSTEM OF PROGRESSION. (See paragraph 329.)

- (f) Type (Encipher) the Message Code Wheel Alignment. The resultant encipherment is the INTERNAL INDICATOR.
- (g) Align, by hand, **both** the Code Wheels of the Alphabet Maze and the Code Wheels of the Stepping Maze to the letters of the Message Code Wheel Alignment (the five letters selected at random (paragraph (e) above.)
- (h) Reset the counter to zero.
- (i) Type the text to be enciphered, using the space bar and alphabet keys only. Spell out numerals. The letter "X" shall normally be used to represent every mark of punctuation. When necessary for clarity, punctuation marks may be spelled out. The only abbreviations for punctuation authorized are PAREN, PARA, and QUES. All punctuation shall be kept at a minimum and used only when necessary to attain clearness. The enciphered text will appear on the tape in groups of five letters. When padding is added at either or both ends to conceal a particularly short message, one in stereotyped form, or one which has been or may be encrypted in another system, the use of spaces and other stereotyped padding must be avoided. (See Chapter IV, **Communication Instructions** for example of objectionable padding.)
- (j) When the text has been completely enciphered, note the counter reading. If it is not a multiple of five, set the Controller to "P" (Plain) and type the letter "X" as many times as are needed to produce a reading which is a multiple of five. Space once. Set the Controller back to "E" (Encipher).

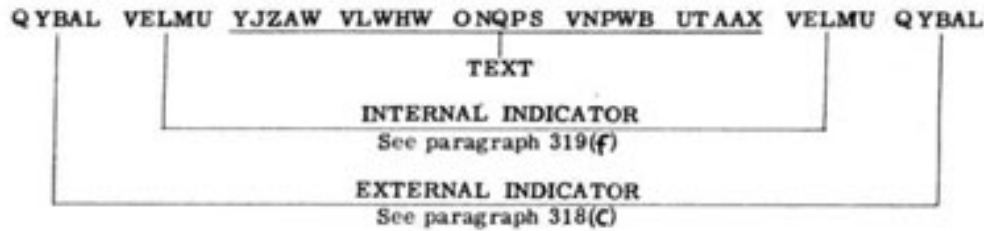
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- (k) Align, by hand, both the Code Wheels of the Alphabet Maze and the Code Wheels of the Stepping Maze to the Initial Code Wheel Alignment. Type (Encipher) the Message Code Wheel Alignment. Check the resultant encipherment with the first Internal Indicator (paragraph (f).) They must be the same.
 - (l) Set the Controller to "P" (Plain). Type the External Indicator.
 - (m) Advance the tape until all printing is clear of the tape channel and tear off the tape.

320. **EXAMPLE.**

- (a) The following example represents the appearance of a message enciphered In this manner. It is based on the sample-Key Setting shown in paragraph 317 (a). QYBAL Is assumed to be the CONFIDENTIAL

External Indicator.



321. DECIPHERMENT.

- (a) Arrange the Code Wheels in accordance with the Key List and set the Index Wheels in accordance with the classification of the message.
- (b) Make the 26-30 Letter Check.
- (c) Turn the Controller to "D" (Decipher) and set the Zeroizer to "Operate". Align, by hand, **both** the Code Wheels of the Alphabet Maze **and** the Code Wheels of the Stepping Maze to the **Initial** Code Wheel Alignment given in the Key.
- (d) Type (decipher) the Internal Indicator. The resultant decipherment is the Message Code Wheel Alignment.
- (e) Advance the tape until the portion of the tape containing the Message Code Wheel Alignment is clear of the tape channel. (These five letters must be destroyed after use and must **not** appear on the delivery copy of the message). -
- (f) Set the Controller to "P" (Plain) and type any identification data desired. Set the Controller to "D" (Decipher) and set the Counter to zero.
- (g) Align, by hand, **both** the Code Wheels of the Alphabet Maze **and** the Code Wheels of the Stepping Maze to the Message Code Wheel Alignment (the five letter decipherment on the tape (paragraph (d))).
- (h) Type the text to be deciphered ignoring spacing between groups. The plain text will appear with normal spacing between words.
- (i) Tear off that portion of the tape containing the Message Code Wheel Alignment and destroy by burning.

PARALLEL OPERATION

322. PARALLEL OPERATION.

(a) Parallel operation of the ECM is not recommended except in unusual circumstances. Experience has shown that the reliable operating speed of the parallel arrangement is far below that of a single machine. The two machines tend to "out of step" if this speed is exceeded. For this reason, and because general use of parallel operation would require a number of machines far in excess of the number available, parallel operation should be kept at a minimum.

(b) The following instructions for Parallel Operation are given for instances in which its use is authorized.

323. PREPARATION OF MACHINES FOR PARALLEL OPERATION.

(a) Both machines must be equipped with motors designed for operation on the same type power.

(b) To prepare the machine for parallel operation:

(1) Determine which machine has the higher speed;

(A) Prepare each machine for individual operation.

(B) Set the Controller of both machines to "R", and reset the Counters to zero.

(C) Press both "Repeat" Key Levers. Simultaneously press both "Blank" Keylevers, and hold them down approximately one minute. Release the Keys simultaneously, and turn both machines off.

(D) Note the Counter readings. The machine with the higher Counter reading should be used as **the secondary** machine (to the right), the machine with the lower Counter reading should be used as the **master** machine (to the left).

(2) Disconnect the power cord of the secondary machine from the source of power. (Secure it in manner which will prevent accidental re-connection).

(3) Replace the fuses in the master machine with 10 ampere fuses. (This is necessary because 5 ampere fuses are insufficient to start both motors at the same time. Five (5) ampere fuses will work, **if** the master machine is always started first, **then** the secondary machine.

(4) Place the secondary machine to the right of the master machine. Using the Connecting Cable (ENG 111) connect from the "Output" of the master machine to the "Input of the

secondary machine. The machines are now ready for parallel operation.

324. **OPERATING PROCEDURE.**

- (a) Set the Zeroizers of both machines at "Zeroize" and both Controllers at "R" (Reset).
- (b) (1) Zeroize the master machine according to previous instructions.
 - (2) Set the master machine Zeroizer at "Operate" and make the Code Wheel Alignment from its own keyboard in the normal manner.
 - (3) Set the Zeroizer to "Zeroize".
- (c) Zeroize the secondary machine and make the Code Wheel Alignment from its keyboard in the normal manner.

CAUTION: Both machines cannot be set up from a single keyboard.

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- (d) Set both machines to "P" (Plain), with the Zeroizers at "Operate" and operate the space bar once.* Type the plain text of the Heading and any other pertinent data. If it is desired that the secondary machine not print this matter, turn the Controller to "Off" position.

*NOTE; It is necessary to operate the space bar only on **some** machines. The purpose of this operation is to clear any stop-pins unlatched on the Printer.

- (e) Set the master machine to "Encipher" and the secondary machine to "Decipher". Reset both counters to zero and proceed with the encipherment. The master machine will print the enciphered text, the secondary machine will print the decipherment of the enciphered text.

NOTE: Always use the master machine for encipherment. In so doing, the electrical impulses of the encrypted text travel through the alphabet maze of the secondary machine and are deciphered, producing a decipherment of the encipherment. If the right hand machine is used as a master, the left hand machine will act merely as a printer indicating only the keylever which has been depressed on the right hand machine. No check on the correctness of the enciphered text will result unless the machines are used in the manner indicated.

325. **EMERGENCY OPERATION.**

- (a) To prepare the machine for operation on an emergency power supply of 24 volts, DC:

- (1) Disconnect the power lead.
- (2) Interchange the position of the motor plug (designated "DC" or "AC", depending upon the type of motor) and the indicator plug so that the pointer of the indicator plug points to "24 DC". See Plate 8c.
- (3) Raise the pawl from the channel ring and slip the channel ring to the outside, allowing the pawl to engage the ratchet (See Plate 8c).
- (4) Connect the power lead to a source of 24 volts direct current. (See para. 211(d).)
- (5) Proceed with the normal operation of the machine except, for each Key lever pressed, completely depress the emergency hand drive lever once. Make a full down stroke for each letter and permit the motor to stop before pressing the next letter. Do **not** "pump the handle". Emergency operation cannot be hurried; it is a slow process.

CAUTION: HOLD THE KEYLEVER DOWN DURING THE ENTIRE TIME NECESSARY TO COMPLETE THE CYCLE. This is most important when making the Code Wheel Alignment.

(b) When operating with low voltage it is **ABSOLUTELY ESSENTIAL** that the contacts of the Code Wheels and Cipher Unit be clean. (See paragraph 403.)

(c) To return the machine to normal operation:

- (1) Lift the pawl and slide the channel ring under the pawl and allow the pawl to engage the channel of the ring. (See Plate 8.)
- (2) Interchange the position of the Motor plug and Indicator plug, so that the Indicator plug points to "115" volts. (See Plate 8.)
- (3) Connect the power lead to the normal source of power.

326. CORRECTION OF ERRORS.

- (a) During encipherment, if the wrong keylever is pressed, that letter only will be in error. The decipherment will appear exactly as typed - with a one letter garble. It is essential that no attempt be made to correct the actual error other than a complete re-encipherment. The error may be ignored, and if the check-decipherment is intelligible without confusion, leave the one-letter garble in the text. If desired, the word "ERROR" or the letter "E" repeated several times, may be enciphered followed by the last correct word, proceeding with the encipherment from that point.
- (b) During decipherment, if the wrong keylever is pressed, that letter only will be in error. If the error is ignored and the decipherment continued, only a one letter garble will result, and the text should be easily completed by inspection.
- (c) If the check-decipherment reveals the omission of entire words or phrases, the best practice is to re-encipher the text in its entirety.
- (d) In order to check the encipherment or decipherment of a certain portion of the text or to recommence decipherment at the point at which a garble occurs:

- (1) Check the first letter of the portion of the text to be checked and determine the interval from the beginning of the encipherment (or decipherment) to this letter.

NOTE: It is recommended that the check be started one or two groups (five or ten letters) before the point of the garble to insure that the starting point has been correctly determined.

(A) On encipherment, the interval is difficult to determine because it is necessary to count each letter of plain text plus the spaces, assuming the original typist did not make errors. If the portion to be checked has just been typed, the counter reading may be noted and the interval "counted back" and one added to the number thus obtained.

(B) On decipherment, the interval may be determined from the regular arrangement of the cipher groups.

- (2) Zeroize and align the Code Wheels.

- (3) Set the Controller at "E" (Encipher) or "D" (Decipher), according to the process desired, leaving the "Zeroizer" at "Operate". Reset the Counter to zero.

- (4) Press the "Repeat" Keylever, then the "Blank" keylever and allow the Code Wheels to step until the counter reading approaches the interval previously determined, then release both Keylevers. Using the "Blank" keylever step the Code Wheels until the Counter reading is one

less than the recorded interval.

NOTE: The paper tape feed can be suppressed by holding the tape release tab down while the Code Wheels are being stepped with the "Blank" keylever.

(5) Record the alignment of **all** Code Wheels and the Counter reading.

(6) Proceed with the encipherment (or decipherment) from the letter previously checked.

(A) If the printed text is garbled, reset the Code Wheels, by hand, to the alignment previously recorded (paragraph (5) above). Proceed with the encipherment (or decipherment) but begin with one letter previous to the letter checked.

(B) If the printed text is still garbled, reset the Code Wheels, by hand, to the alignment previously recorded and proceed with the encipherment (or decipherment) but begin one letter after the letter checked.

(C) If the text is still garbled, try adding two letters then subtracting two letters, etc. until five letters plus or minus have been tried. Failure of correct text to appear indicates that an incorrect alignment has been used, the machine is not functioning properly, or that an error has been made in computing the interval.

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327. **GARBLES.**

(a) Should decipherment fail completely:

(1) If the letters of the two Internal Indicators at the beginning and end of the message are not identical, try the various combinations until an alignment is obtained that will produce intelligible text.

(2) The External Indicator of one classification may have been used for the message, but an Index Setting for another classification may have been used. Try all the Index Settings given in that particular Key Setting.

(3) The Key Setting for the previous or following day may have been used.

(4) The enciphering machine may have been defective or the enciphering operator may have failed to make the 26-30 Letter Check. Try the process given in paragraph 328.

(5) When using the Joint Army-Navy method of operation one additional garble is possible. If the operator should select a "Z" in violation of paragraph 319 (e) the Internal Indicator will decipher with an "X" in the Message Code Wheel Alignment Instead of the "Z". In this case, try substituting a "Z" for an "X" in the Message Code Wheel Alignment.

A MESSAGE WHOLLY UNDECIPHERABLE MUST BE TRIED BY THE PROCESS GIVEN IN THE NEXT PARAGRAPH BEFORE A SERVICE IS REQUESTED.

328. SPECIAL CHECKING PROCESS FOR "SIMPLE-SUBSTITUTION".

- (a) A mono-alphabetical ("simple-substitution") cipher capable of being solved by an amateur cryptanalyst can be produced by the ECM if certain operating procedures are not faithfully followed by the operator.
- (b) The primary cause of the production of a simple substitution cipher is the mis-alignment of an Index or a Code Wheel. If an Index Wheel is not accurately positioned, the stepping control circuits to the Code Wheels of the Alphabet Maze will be broken, and the Code Wheels of the Alphabet Maze will not step. If a Code Wheel of the Stepping Maze is not accurately positioned (generally in Joint Army-Navy method of operation wherein the Code Wheels are aligned by hand) the stepping circuits will also be broken. The resultant encipherment in either case will be a "simple-substitution".
- (c) The operator can definitely insure against the production of a simple substitution cipher by faithfully performing the 26-30 Letter Check, and, when using the U.S. Navy general method of operation, checking the alignment of the Code Wheels of the Alphabet Maze after making the Code Wheel Alignment to see that all five are not aligned to "O". A machine capable of producing a "simple-substitution" encipherment will not give the correct 26-30 Letter Check, nor will the check-decipherment, if properly performed, decipher.
- (d) When a message is wholly undecipherable, in order to check the possibility of its having been enciphered on a machine improperly adjusted:
 - (1) Prepare the machine for operation in the normal manner, except turn any Index Wheel between two numbers or remove it entirely.
 - (2) Set the Controller at "D" (Decipher) and set the Zeroizer to "Operate". Reset the counter to zero.
 - (3) (A) If the message was enciphered by the standard U.S. Navy method of operation, zeroize the Code Wheels, and leave them aligned to 00000.

(B) If the message was enciphered using the Joint Army-Navy method of operation, align by hand, the Code Wheels of the Alphabet Maze to the Initial Code Wheel Alignment and decipher the Internal Indicator to produce the Message Code Wheel Alignment. Align, by hand, the Code Wheels of the Alphabet Maze to the resultant Message Code Wheel Alignment. (The Code Wheels of the Alphabet Maze must not step during this process.)

NOTE: For either method of operation, the Code Wheels of the Stepping Maze may be ignored entirely since the mis-alignment of the Index Wheel prevents these Code Wheels from controlling the stepping of the Code Wheels in the Alphabet Maze. For this reason, when using either method of operation, a Code Wheel Alignment need not be made on the Code Wheels of the Stepping Maze.

(4) Type (decipher) the message. While deciphering, the Code Wheels of the Alphabet Maze must remain aligned to the original Code Wheel Alignment (00000 if using standard Navy method, or if using the Joint Army-Navy method, the Message Code Wheel Alignment). If they do not, it indicates the Index Wheel is making contact.

(5) RESET THE INDEX WHEEL TO THE CORRECT ALIGNMENT

(e) If the message deciphers properly it indicates the enciphering machine was operating incorrectly. The deciphering activity should report, as opportunity affords, to the enciphering activity with information to the Chief of Naval Operations any message so deciphered.

(f) The deciphering activity must not relay the cipher text of a message enciphered in the above manner, but should re-encipher the message. Prior to re-encipherment, the order of sentences should be changed. Different indicators and Date-Time Group should be used, and other standard re-encipherment practices followed to prevent linkage with the original message.

(g) The seriousness of such an encipherment cannot be over-emphasized. A simple substitution can result only through carelessness of the operator. **THIS CARELESSNESS IS INEXCUSABLE.** The ECM Mark 2, like any machine, is not fool-proof. Common sense and faithful observance of instructions on the part of the operator are essential.

(h) OPERATORS MUST TAKE CARE TO USE THE ECM PROPERLY.

329. RANDOM SELECTION OF CODE WHEEL ALIGNMENTS.

(a) Code Wheel Alignments **must** be selected at random and any definite system of progression must **not** be followed. Random selection of Code Wheel Alignments is imperative to insure the greatest possible variety of starting points. A Code Wheel Alignment which is not selected at random is likely to be repeated using the same Key Setting. Two messages with the same starting point is a condition sought by cryptanalysts.

(b) There are several methods which may be employed to produce random Code Wheel Alignments:

(1) Cipher groups may be selected at random from a group of messages.

(2) An average of one out of ten letters may be deleted from the cipher groups of a message, and the letters used consecutively.

(3) Poker chips or cards may be labeled with the letters of the alphabet and five selected at random for each setting.

(4) A cipher machine may be prepared for encipherment using a random Code Wheel Arrangement and the keys depressed at random or a cipher message typed. Letters of the cipher groups thus produced may be used consecutively for Code Wheel Alignments.

(c) In each case, the letters "O" and "Z" should be deleted to prevent accidental use.

330. MESSAGE LENGTH.

(a) Very long messages to be enciphered with the ECM Mark 2 should be broken up into parts, each of which uses a different Code Wheel Alignment. Each part should not exceed three-hundred and fifty (350) groups in length.

(b) This limitation on message length is imposed, for convenience in traffic handling and for uniformity of procedure between the services. The cryptographic security of the ECM is not involved.

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Version 1.01, 23 May 05

PART IV

MAINTENANCE

401. ROUTINE MAINTENANCE.

(a) The following policy of routine inspection and overhaul has been established:

Whenever possible and according to circumstances:

- (1) A routine inspection of the ECM at a regularly established ECM Repair Facility, every 30 days.
- (2) A routine complete overhaul of the ECM at a regularly established ECM Repair Facility every twelve months.

(b) Between these inspections and overhauls there are certain operations which must be performed by the operator. This section of these instructions is designed as a guide for the operator of the ECM, who must necessarily be responsible for the daily maintenance and up-keep of the ECM. Only a small amount of time is necessary to insure that the machine is properly maintained. Some maintenance duties must be performed daily, others require only a few minutes each week. A machine which is properly maintained will give a minimum of trouble.

402. LUBRICATION.

(a) The Spare Parts Box (ENG 109) issued with each machine supplies oil, grease and a one drop oil can.

(b) (1) Plates 3 and 4 are included to assist in locating the oil holes of the various units. It will be noted that, in many of the parts, felt wicks have been provided to receive the oil rather than the bearing surfaces of the parts themselves.

(2) CARE SHOULD BE TAKEN TO PREVENT OIL OR GREASE FROM GETTING ON THE CODE WHEELS, INDEX WHEELS, CIPHER UNIT, SEPARATORS, CONTROLLER AND KEYLEVER CONTACTS AND WIRING.

(c) Oil the following points sparingly, once every two weeks.

(1) Stepping Pawls and Stepping Pawl latches - one drop.

(2) Stepping drive bars - felt wick in rear guide and forward pivot points.

See Plate

3(c)

3(c)

4(a)

- | | |
|--|------|
| (3) Stepping bell crank, several drops in oil holes at pivot points. | 4(c) |
| (4) Tape feed drive; rear bearing - fill oil cup. Front bearing - few drops. | 4(d) |
| (5) Friction drive felt washers, several drops on each. | 4(b) |
| | 4(d) |
| (6) Clutch magnet armature pivot and clutch stop lever pivot - one drop. | 3(b) |
| (7) Printer stop pins, one drop on tip of each stop pin. | 4(b) |
| (8) Print hammer pivot screw - one drop. | -- |
| (9) Clutch mechanism - several drops. Ball bearings (two) - few drops. | 3(a) |
| (10) Motor - ball oilers (two). | -- |

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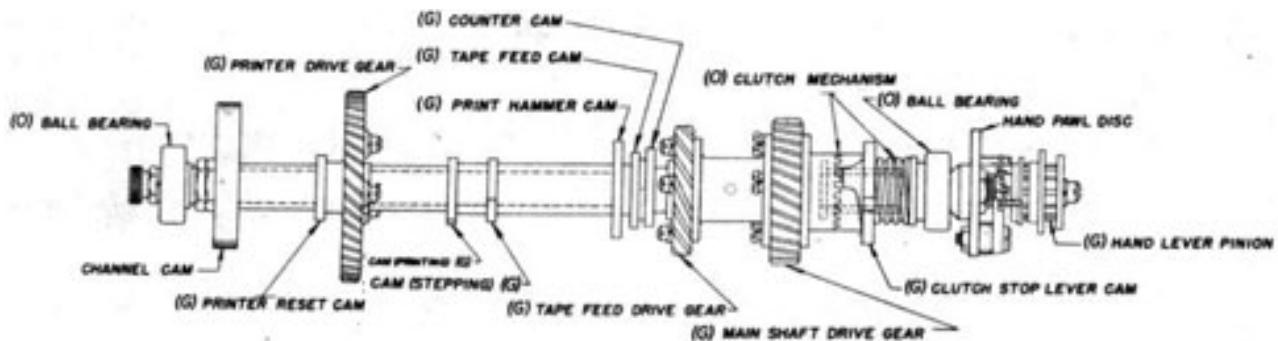


PLATE 3A - MAIN SHAFT

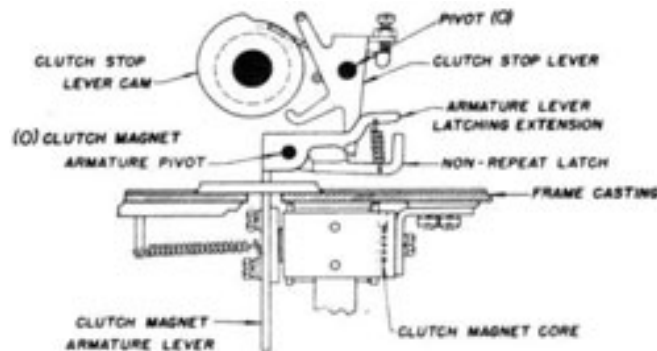


PLATE 3B - MAIN SHAFT
(Right End View)

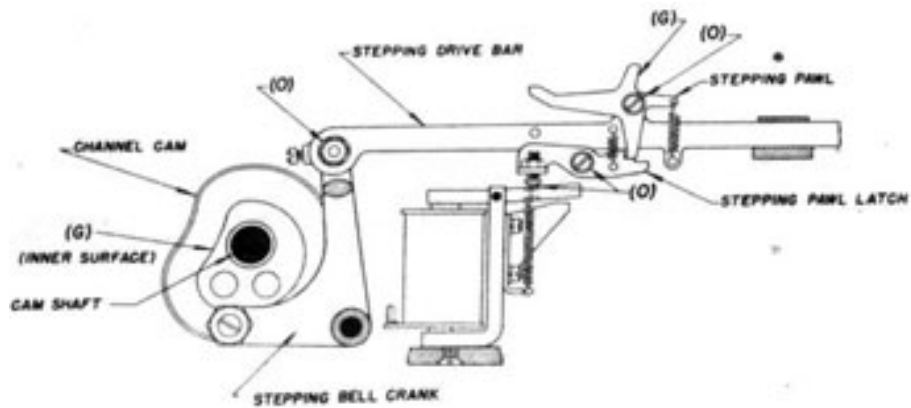


PLATE 3C - CODE WHEEL STEPPING MECHANISM
PLATE 3

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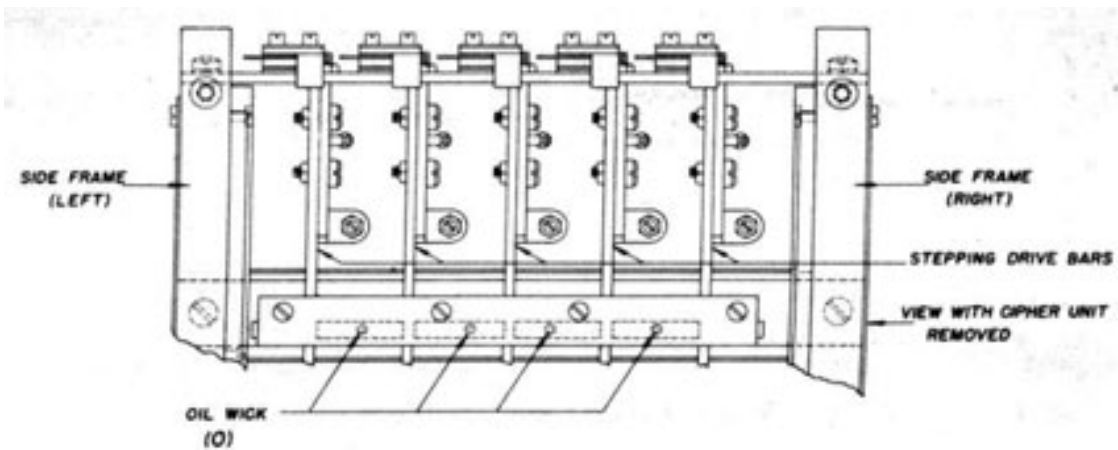


PLATE 4A - CIPHER UNIT CAVITY

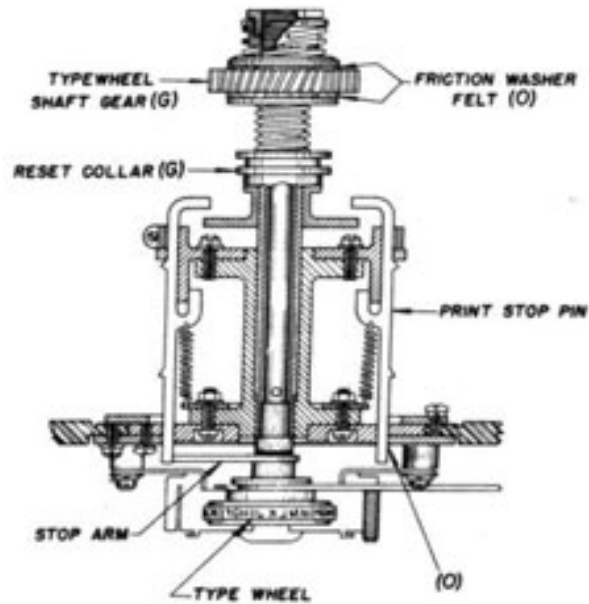


PLATE 4B - PRINTER

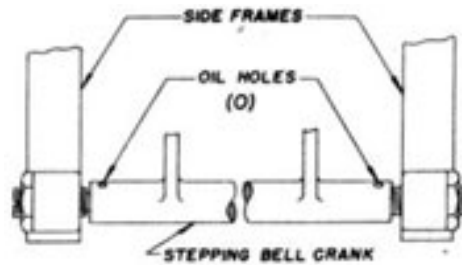


PLATE 4C - BELL CRANK
(Stepping Mechanism)

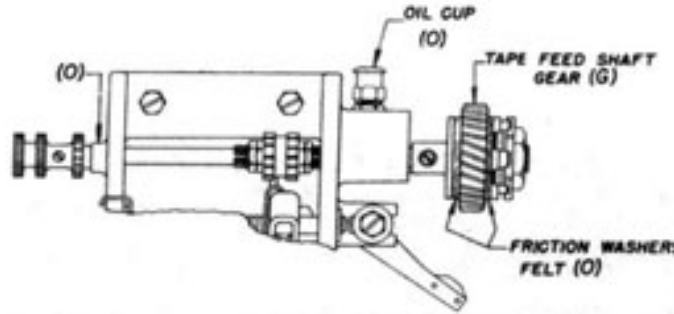


PLATE 4D - TAPE FEED DRIVE
(Right Side of Printer)
PLATE 4

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(d) Apply grease sparingly to the following points, once every two weeks when the machine is in constant use:

	See Plate
(1) Channel cam- inner surface in contact with roller.	3(c)
(2) Stepping pawl, point of contact with reset screw.	3(c)
(3) Tape feed shaft gear.	4(d)
(4) Typewheel shaft gear, reset bail groove.	4(b)
(5) Printer reset cam, timing cams, print hammer cam, tape feed cam, counter cam, clutch stop lever cam.	3(a)
(6) Printer drive gear, tape feed drive gear, and main shaft drive gear.	3(a)
(7) Motor pinion (on motor shaft).	---
(8) Controller detent roller and cam surface.	---

CAUTION: Rub the grease in and clean up any surplus grease which may drop from the parts after the machine has run a few minutes.

(e) At the time of oiling, (and more often if necessary) wipe the Code Wheel spindles with an oily cloth. The Code Wheels must not run on a dry spindle.

403. CLEANING CONTACTS.

(a) Experience has shown that the major cause of unreliable operation is dirty contacts of the Cipher Unit. Clean contacts are absolutely necessary for proper functioning of the machine. The only reliable method of maintaining clean contacts, except where an approved Code Wheel lubricant is used, is to follow a daily cleaning schedule. This will not only insure the removal of any dirt which may have been deposited but also will remove any "carried over" metal which may have been ground off the contacts.

(b) The lid should be removed only as required for changing Code Wheels, making Index Settings, lubrications, etc. It should be kept in place at all other times.

(c) (1) The plunger-contacts of the Cipher Unit must be inspected and cleaned DAILY, except where an approved Code Wheel lubricant is used. The Spare Parts Box (ENG 109) contains a canvas paddle which is especially designed to fit between the Cipher Unit Separators. The outside plunger contacts should be rubbed with one side of the canvas paddle.

(2) When the canvas becomes soiled, it should be removed and cleaned. If cleaning solutions are used it must be rinsed several times in water to insure all cleaning solution is removed. The canvas should be stretched tightly when re-assembled on the wooden form.

(d) To clean the contacts of the Code Wheels, place a piece of canvas on a smooth flat surface and rub the Code Wheel and Index Wheel contacts against the canvas until they have become clean and bright. If in some cases the hub of the Code Wheel will not permit the Code Wheel to lay completely flat, two blocks should be laid side by side with a space between them, forming a depression in which the hub of the Code Wheel will ride, permitting the Code Wheel Contacts to lay flat on the canvas,

(e) If, because of infrequent cleaning, the contacts cannot be cleaned with the canvas paddle, a pencil (not ink) eraser may be used. The standard flat type, about two inches long is a convenient size. It must be clean and free from abrasive material. The use of the eraser must always be followed by cleaning with the canvas paddle.

404. **CODE WHEEL LUBRICANT.**

- (a) A special Code Wheel Lubricant is being made available to all holders. Initially small quantities will be forwarded to the Registered Publication Issuing Offices, as a matter of convenience in distribution, but regular distribution will be through the ECM Repair Facilities.
- (b) Until the lubricant is available, or if the supply is temporarily exhausted, the standard method of cleaning Code Wheels should be followed.
- (c) The use of the Code Wheel lubricant requires the cleaning of the Cipher Unit and Code Wheel contacts at intervals of **two four weeks** instead of **daily**.
- (d) The approved lubricant is commercially known as "Lubriplate" formula 105.

NOTE: "Lubriplate" is extensively used throughout the Navy In connection with other equipment, but in most cases It is not formula 105, which is the only type "Lubriplate" authorized for a Code Wheel lubricant.

- (e) "Lubriplate" is light cream in color and has a viscosity similar to petroleum jelly.
- (f) To apply "Lubriplate":
 - (1) Clean the contacts of the Code Wheel, Index Wheel and Cipher Unit in accordance with paragraph 403. Wipe the contacts with a clean cloth to insure that all dust is removed.
 - (2) Place a very small quantity of "Lubriplate" 105 on the contact surfaces of the Code Wheels and Index Wheels. Rub the lubricant into the surface of the contacts.

NOTE: Do not lubricate the contacts of the Cipher Unit.

- (3) Polish the faces of the Code Wheels and Index Wheels with a lint-free cloth. Remove any excess lubricant.

- (g) "Lubriplate" should be applied at intervals of two to four weeks, depending upon use and local conditions.
- (h) THE USE OF ANY OTHER LUBRICANT, OR OF "LUBRIPLATE" IN ANY FORMULA OTHER THAN "105" IS NOT AUTHORIZED.

INFREQUENT OPERATIONS

405. **PRINTER RIBBON.**

- (a) A standard 1/2 inch typewriter carbon ribbon (such as used on an Underwood typewriter) is used on the Printer. A Hectograph ribbon may be used if preferred.
- (b) The ribbon feed is reversed by moving the ribbon reverse lever towards the spool upon which the ribbon is to be wound.
- (c) Only one-half of the ribbon is used at a time, and after one-half fails to print clearly, the ribbon should be inverted to use the other half. This is accomplished by reversing the respective positions of the spools (i.e., the left spool to the right position and the right spool to the left position) and replacing the ribbon in the ribbon guide. When replacing the spools on the shafts be sure the small pin on the hub of the shaft engages the spool, thus preventing the spool from slipping on the shaft.

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- (d) To insert a new ribbon:

- (1) Allow the ribbon to accumulate on either spool. Disengage the ribbon from the ribbon guide. Remove the spools from the shaft by pulling straight out (the spools are mounted on split shafts).
- (2) Disengage the ribbon from the empty spool, discarding the ribbon and the spool on which it is wound.
- (3) Engage the new ribbon to the center of the empty spool.
- (4) Replace the spools on the shafts so the ribbon runs to the outside of both spools.
- (5) Replace the ribbon in the ribbon guide.

406. **PAPER TAPE REPLACEMENT.**

- (a) Paper tape is a "supply" Item and is not normally procurable from ECM Repair Facilities or Registered Publication Issuing Offices. In some cases, a small supply of tape is carried in stock at these places, but only as an emergency supply. Each ship or station should anticipate its needs and order an adequate stock well in advance of actual needs. Activities from whom paper-tape can be obtained are as follows:

Stock Maintenance List
Navy Type - 10055
Paper Tape

Navy Yard or Base	Maximum Stock (Rolls)	Minimum Stock (Rolls)
New York	40,000	5,000
Mare Island	40,000	5,000
Boston	2,000	500
Portsmouth (N.H.)	500	250
Sub-base, New London	2,000	500
Philadelphia	1,000	250
NYD, Norfolk	500	250
NOB, Norfolk	10,000	5,000
Washington	5,000	2,000
Charleston	2,000	500
NS, Key West	2,000	500
NSD, San Juan	2,000	500
NS, Guantanamo	500	250
NSD San Diego	2,000	500
Puget Sound	10,000	5,000
Pearl Harbor	10,000	5,000
NS, Balboa	1,000	250
NS, New Orleans	1,000	250
Sub-base, Coco Solo	1,000	250

(b) The paper tape used in the ECM Mark 2 is a special gummed tape made according to U.S. Navy specifications. It is not affected by high humidity and will not become loosened from the message blank with age. Ordinary 3/8 Inch paper tape (plain or gummed) may be used in an emergency, but it is not recommended. Two types of special ECM tape are available:

Navy Type No.	Width	Layers	Length	Groups	Price	Rolls to Box
CPM 10055	3/8"	1	1100 ft.	18,000	\$0.15 ea.	10
CPM 10056	3/8"	1 plus carbon	500 ft.	8,000	\$0.25 ea.	10

(c) To replace the paper tape:

- (1) Raise the tape retainer arm and remove the wooden spool.
- (2) Unwind about two turns from the new roll of tape, place the spool of the tape on the spindle so the tape roll will turn clockwise when unrolling and replace the tape retainer into position.
- (3) Thread the end of the paper tape through the tape roller (gummed side up) and into the cover tape channel with the gummed side out.
- (4) Press the tape release tab and push the paper tapes (gummed side down) between the tape feed rollers and through the printer tape channel. Release the tape release tab.
- (5) Thread the paper tape around the idler roller.
- (6) Examine the "mesh" of the feed rollers; the paper tape should be held tightly.

407. CAUTIONS.

(a) Throughout this publication, several "Cautions" have been Inserted. Those which affect the maintenance and upkeep are summarized as follows:

- (1) The lid should be removed only as required, such as changing Code Wheels, making Index Settings, etc. It should be kept in place at all other times.
- (2) Code Wheels must be handled carefully, and kept in the box when not in use. Fingers should be kept from the contacts as much as possible. The Code Wheels should be carefully inserted into the Cipher Unit - the cam-lobe (the "bump" between "U" and "V") is easily broken off, rendering the use of the Code Wheel dangerous when used in certain positions.
- (3) Both hands must be used when inserting the Cipher Unit into and removing it from the machine, otherwise the Cipher Unit, its frame, or the zeroizing contacts may be damaged. All four thumbscrews should be securely tightened.
- (4) The pawl and channel ring must be adjusted so the hand drive lever is free to move up and down except when actually using emergency power.
- (5) The contacts of the Cipher Unit, Code Wheels and machine must be kept scrupulously clean.

- (6) Lubrication instructions must be faithfully followed.
- (7) Keep the lamp in the Type 8 Safe Locker on continuously.
- (8) The ribbon feed must be reversed by hand.

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Version 1.01, 23 May 05

PART V**REPAIR****501. GENERAL.**

(a) For the purpose of periodic maintenance, service and repair, Major ECM Repair Facilities, Intermediate ECM Repair Facilities, and Minor ECM Repair Facilities have been established at the following locations:

MAJOR ECM REPAIR FACILITIES

Naval Code and Signal Laboratory, Washington, D.C.
 Navy Yard New York
 Navy Yard Mare Island
 Navy Yard Puget Sound
 Navy Yard Pearl Harbor
 Naval Operating Base Oran
 Naval Operating Base Noumea
 Naval Operating Base Londonderry
 Naval Operating Base Adak
 Convoy Escort Base Milne Bay

INTERMEDIATE ECM REPAIR FACILITIES

Navy Yard Boston
 Navy Yard Norfolk
 Repair Base San Diego
 U.S. Naval Drydocks San Pedro
 COM 7 - Miami (RMO)
 COM 15 - Balboa (RMO)

MINOR ECM REPAIR FACILITIES

Navy Yard Charleston
 Navy Yard Philadelphia
 Navy Yard Portsmouth, N.H.
 Naval Station Coco Solo
 Naval Station New Orleans
 Naval Operating Base Dutch Harbor
 Naval Operating Base Key West
 Naval Operating Base Kodiak
 Naval Operating Base Newport
 Naval Operating Base Norfolk
 Naval Operating Base San Juan
 Naval Operating Base Sydney
 Naval Operating Base Argentina
 Naval Operating Base Bermuda
 Naval Operating Base Guantanamo
 Naval Operating Base Trinidad
 Naval Operating Facility
 Naval Camp Parera Curacao
 Submarine Base Midway
 Submarine Base New London
 U.S. Coast Guard Yard Curtis Bay, Md.
 ASS'T. NAVINDMAN San Francisco
 COM 12 San Francisco (Comm. Off.)
 COMAIRSOPAC Espiritu Santo (Comm. Off.)
 COMNAVEU London (Comm. Off.)

SHIPS

USS AJAX
 USS ALCOR
 USS ALTAIR
 USS ARGONNE
 USS BEAVER
 USS BLACK
 HAWK
 USS BRIAREUS
 USS BUSHNELL
 USS CASCADE
 USS DELTA
 USS DENEbola
 USS DIXIE
 USS DOBBIN
 USS EURYALE
 USS FULTON
 USS GRIFFIN
 USS HAMUL

USS MARKAB
 USS MAUMEE
 USS MEDUSA
 USS MELVILLE
 USS ORION
 USS OTUS
 USS PATOKA
 USS PELIAS
 USS PIEDMONT
 USS PRAIRIE
 USS
 PROMETHEUS
 USS PROTEUS
 USS RIGEL
 USS SPERRY
 USS VESTAL
 USS VULCAN
 USS WHITNEY

USS HOLLAND

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(b) ECM Repair Facilities are divided into four classes as follows:

(1) Major ECM Repair Facilities, which stock a large quantity of all spare parts available for distribution to other repair activities and are staffed and equipped to make any repair on all types of cryptographic devices used by the Navy.

(2) Intermediate ECM Repair Facilities, which stock a smaller quantity (40% of a Major Facility stock) of all spare parts available for distribution to Minor Repair Activities and are staffed and equipped to do general overhaul and repair work on all types of Naval cryptographic equipment.

(3) Minor ECM Repair Facilities, which have a stock of the more vulnerable parts of the equipment and are staffed and equipped to make inspection and repairs of a minor nature on all Naval cryptographic devices.

(4) Emergency Minor ECM Repair Facilities, which also have a stock of the more vulnerable, parts of the equipment. The parts are supplied to these activities because of the number of cryptographic devices in use at the activity or because of their geographic isolation from an authorized repair facility. They are not staffed or equipped to render inspection or maintenance service on other than their own equipment except in an emergency.

(c) Each repair facility with the exception of the Emergency Minor ECM Repair Facility is prepared for periodic overhaul of the ECM, and insofar as possible, has been provided spare machines in order that a ship can exchange its machine for a thoroughly re-conditioned machine.

(d) The above ECM Repair Facilities are provided with the "Repair and Maintenance Instructions", Blueprints, Parts Catalogs, etc. and service personnel attached thereto have attended a course of instruction at an ECM training school.

502. TRAINING SCHOOLS.

(a) Schools for the instruction and training of personnel in the repair and maintenance of cryptographic machines are maintained at each of the Major ECM Repair Facilities. Instruction of three weeks duration is given for the purpose of training personnel attached to an individual activity in the technique of cleaning, oiling and performing emergency repairs, utilizing the Spare Parts Box (ENG 109) supplied with each ECM. Two or three day "appreciation" courses are available for communicators to familiarize them with the general mechanical operation, oiling and cleaning of the ECM.

(b) Commanding officers are urged to nominate trustworthy personnel for these schools. Arrangements should be made by directly contacting the Major Repair Facility.

(c) In addition to the Major ECM Repair Facilities, schools are located at the following points:

ECM Repair Facility, Boston
ECM Repair Facility, Norfolk

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503. QUALIFIED AND AUTHORIZED REPAIR PERSONNEL.

(a) Personnel who satisfactorily complete the full course at an ECM training school are issued the card illustrated below. Personnel from a repair facility should be required to present this card and the standard Navy Identification Card before being allowed to service the machine. Holders of qualification cards who are not assigned to duty at authorized ECM Repair Facilities are normally authorized to perform only routine cleaning, oiling and emergency repairs to the extent of the tools and parts available in the ENG 109. The services of the personnel at established ECM Repair Facilities should be utilized to the greatest practicable extent for monthly inspections and major overhaul. Unsatisfactory performance of duties by **any** card holder should be reported to the Bureau of Ships, Code 945.

UNITED STATES NAVY	
(Name)	
(Signature)	
IS QUALIFIED AND AUTHORIZED TO SERVICE EQUIPMENT IN ACCORDANCE WITH CSFM 390.	
(Serial No.)	(Validating Officer)
(Date of Issue)	(Activity)

504. EMERGENCY REPAIRS.

(a) When the ECM requires attention, either for routine inspection, emergency repairs, overhaul, adjustment, etc., service should be requested from the nearest ECM repair facility. Experience has shown that cryptographic machines have suffered more from attempted repairs by inexperienced personnel than from wear and tear, therefore, routine tests and overhauls should be undertaken only by experienced personnel.

(b) It is realized that in many cases the above procedure is not a satisfactory solution to an immediate problem and emergency repairs will have to be effected, if at all possible. The emergency repair instructions given herein are written for the individual who has not had a course of instruction, therefore, they contain no information on adjustment tolerances, repairs requiring special tools, etc. Any emergency repairs effected should be rechecked as soon as practicable in an ECM repair facility.

(c) The effecting of emergency repairs is chiefly a matter of common sense. The decision is the responsibility of the Commanding Officer. For example, with tender facilities available, it would be undesirable to subject the machine to possible mistreatment at the hands of inexperienced personnel. On the other hand, if the machine breaks down while at sea, the ship's force should attempt any repair considered to be within its capabilities, even at the risk of further damage. Reasonable effort must be made to keep the machine in operation.

505. SPARE PARTS BOX (ENG 109).

(a) A Spare Parts Box (ENG 109) has been issued to each activity holding the ECM. The parts included are those required for repairs and maintenance normally considered to be within the capabilities of the ship's force.

(b) The contents of the Spare Parts Box (ENG 109) has been revised from time to time. Each Spare Parts Box currently contains the following items:

Part No.	Description	QTY.
4840	Double end wrench	1
70169	Hand tape moistener	1
72755	Wick for Hand tape moistener	1
75765	Spring hook - pull	1
76084	Friction disc - felt	6
76280	Capstan wrench	2
82285	Resistor, 300 ohm	1
88265	Retaining Bushing	12
88448	Plunger contact assembly	12
88993	Contact burnisher	1
91755	Power switch	1
100013	Print hammer	1
100076	Type wheel	1
100121	Print hammer insert - rubber	6
100129	Friction clutch washer	5
100141	Tape feed pawl	1
100212	Clutch throwout lever	1
100260	Stepping magnet	1
100600	Unwired code wheel	1
100645	Capacitor - 2 mfd.	1
100646	Capacitor - 1 mfd.	1
100648	Resistor - 100 ohms	1
100649	Fuse - 5 amp	5
100688	One drop Oiler	1
100709	Wrench set - Williams	1
100895	ENG 109 Container - metal	1
100919	Fuse - 10 amp	5
100945	Wire #20, 15-foot roll	1
100972	Clutch spring	1
100973	Cleaning block (with canvass)	1
100978	Canvass belt for cleaning block	1
100982	Screwdriver - 6 inch	1
100983	Oil - 8 oz. can	1
100984	Grease - 2 oz. tube	1
108095	Nut, 4-40	6
108101	Screw 4-40 flat head	6
108102	Screw	3
108261	Plunger tool	1
108663	Contact spring	1
110426	Clutch magnet complete (old number M-222)	1
110437	Spring (old number 35-70)	1

EMERGENCY REPAIRS**506. ZEROIZING.**

(a) Condition: Code Wheels will not zeroize.

(b) Probable cause:

(1) The zeroizing springs are bent out of adjustment. The cam-lobes (see plate BA) are so situated that, when the Code Wheel is aligned to "O", the spring contact of the zeroizing contact will be shifted to open the circuit. Bend the zeroizing spring of the faulty Code Wheel position back into shape, using the others as a guide. Turn the Code Wheel by hand and observe the action of the cam-lobe against the spring contact until the cam-lobe opens the spring contact.

NOTE: If any of the Code Wheels EXCEPT the center Code Wheel of the Stepping Maze **and** the one immediately to its right (#3 and #4) fail to zeroize, they may be zeroized by hand. If #3 and #4 Code Wheels of the Stepping Maze will not zeroize DO NOT USE THE MACHINE UNTIL CORRECTED.

507. CODE WHEELS OF STEPPING MAZE.

(a) Condition: None of the Code Wheels of the Stepping Maze step.

(b) Probable cause:

(1) The Stepping Timing Contact may be dirty or out of adjustment (See Plate 6). When the main shaft is at rest, this contact is held open, but is closed immediately after the main shaft commences to turn. Shift to emergency hand power operation (para. 325) and slowly turn the main shaft and observe the action of this contact. Clean the contact and **if necessary** bend the spring so it will make contact properly.

508. CODE WHEELS OF ALPHABET MAZE.

(a) Condition: None of the Code Wheels of the Alphabet Maze will step.

(b) Probable cause:

(1) A Code Wheel or Index Wheel may be turned "half way" so that the circuits are not completed.

509. KEYLEVER FAILURE.

(a) Condition: All of the Keylevers are inoperative.

(b) Probable causes:

(1) The Print Timing Contact (See Plate 6) may not be making contact. When the main shaft is at rest, this contact is closed, but opens immediately after the main shaft commences to turn. Clean the contact and **if necessary** bend the contact spring so the contact is closed in the normal unoperated position of the main shaft.

(2) The Clutch Magnet circuit may be open. Examine the connections from the magnet winding to the solder lugs.

(3) The spring attached to the clutch stop lever above the casting on the right hand end of the main shaft may have come off the spring post. Replace the spring.

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(c) Condition: A single Keylever fails to print on "P" (Plain).

(d) Probable causes:

(1) A Printer magnet may be shorted or burned out or the circuit may be broken, 1.1 a Printer Magnet becomes shorted, the printing associated with that magnet will be smudged, but otherwise the operation of the machine is unchanged. if a printer magnet circuit is open, the machine will fail to operate each time a keylever is pressed which should result in the energizing of that magnet. The Printer should not be opened because special tools are required for re-assembly. The best practice to follow in case of an opened printer magnet or circuit is to type slowly, making sure each Keylever depressed operates the Printer. When the depressing of a key fails to operate the Printer, press the "Blank Key". This will produce a blank on the tape which will have to be filled in later, but the machine will be in step for succeeding letters. The letter to be filled in is determined by the letter failing to print when typing plain.

(2) On encipherment or decipherment the failure of a letter to print (when all letters print properly on plain) almost always is caused by a contact failure through the Alphabet Maze. Clean the contacts. Examine the Code Wheels for bad connections. Hold the Keylever down and "wiggle" the Code Wheels. The best practice is to press the Blank Key or another Key which will produce a one-letter garble which ordinarily is capable of being cleared by inspection.

(3) A Controller contact may be operating improperly.

510. **MOTOR FAILURE.**

(a) Condition: The motor fails to start.

(b) Probable causes:

(1) Fuses, are burned out. Unscrew the fuse holder and remove the fuses. Replace the fuses with new fuses and replace the holder.

NOTE: If a fuse "sticks" in the holder, remove the cover (two screws in front, one at each side and one in the rear, inside the case). Take a small stiff wire and punch the fuse out by inserting the end of the wire through the hole in the solder lug at the bottom of the fuse-holder.

(2) The switch which controls the motor is located on a bracket attached to the top of the Controller and is turned on and off by a mechanical link to the Controller shaft. Check the relative position of the switch to insure that it is actually snapped when the Controller handle is turned away from "O" (Off).

511. **26-30 LETTER CHECK.**

(a) Condition; The 26-30 Letter Check is not produced.

(b) Probable cause:

(1) Try the Stepping Check of para. 308 and observe the stepping of the Code Wheels of the Stepping Maze. The zeroizing contacts of the #3 and #4 Code Wheels have an additional contact spring for the purpose of producing the automatic stepping of the Code Wheels. (See para. 203(d) for Stepping Control). When the cam-lobe of the Code Wheel engages the contact spring, it should be held away from the contact spring nearest the Code Wheel and should be in contact with the spring nearest the front of the machine.

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512. PRINTING.

(a) Condition; Printing on the tape is smudged, or indistinct.

(b) Probable causes:

(1) The type wheel is turned by a friction clutch composed of two felt washers separated by the drive gear and retained by a flange of the printer shaft on the forward side and a friction disc at the rear. Should this assembly become loose, or the friction washers worn, the type wheel will not be turned fast enough or will not be held motionless during the printing of a character. Part No. 76084 is the replacement part. Part No. 76280 Is the Capstan wrench for use with the printer. To replace the friction washers:

(A) Disconnect the power from the machine and remove the Cipher Unit. Remove the cover (two securing screws are located on the front at the sides of the cover and one is located inside the cover at the rear). Engage the hand drive, manually trip the clutch and rotate the main-shaft until the stepping drive bars have reached their maximum forward travel. Remove the bracket from the right top of the printer and disconnect the two Jones receptacles at the top left of the printer. Remove the two screws through the rear feet of the printer and remove the two nuts from the studs through the front feet of the printer. Raise the printer until the front feet clear the studs and withdraw the printer from the machine.

(B) Using a 3/4 inch wrench and the Capstan wrench, remove the locking nut and spring seat from the rear end of the printer shaft. Remove the friction disc and felt washer, the drive gear and front felt washer, and replace with new washers which have been saturated with light oil.

(C) Reassemble in reverse order. When replacing the drive gear on the printer shaft the recess in the gear should face away from the printer so that the recess will hold the rear friction washer centrally with respect to the shaft and **away** from the threads of the shaft.

(D) Re-install the printer. Hold the printer so the print hammer follower and feed pawl followers are in line with their associated cams, and so the holes in the front feet are in line with the mounting studs. Lower the printer carefully, making sure that the feed shift lever and keeper straddle the feed shift arm. Take up the play of the printer toward the rear and to the right and tighten the printer mounting screws and nuts. Insert the printer receptacles and fasten the retainer arm. Re-fasten the bracket to the right top of the printer.

(E) Manually trip the clutch and slowly turn the main shaft several times and

observe that all mechanical action takes place smoothly.

(F) Connect the machine to power. Set the Controller at "P" (Plain) and the Zeroizer to "Operate". Depress any key. Tighten the spring seat until the printing on the tape becomes legible.

(2) if the "M" and "W" are not distinctly printed at the outer edges, it may be that the Print hammer insert is not wide enough on the striking surface. Replace with a new insert. If only one side of the letter is printed, make the adjustment of the following paragraph.

(3) if the typewheel is broken or no longer serviceable and is to be replaced, remove the three screws which hold it to the typewheel shaft. Remove the damaged typewheel and replace it with a new one, reinstalling the screws. The screw holes are so placed that the typewheel will fit only one way. Barely tighten the three screws and alternately type "M" and "W". If necessary, loosen the screws, shift the typewheel in the proper direction and retighten the screws. (Caution: Don't twist the screws off.)

(4) if the letters tend to print one on top of another, it may be the paper tape is not free to unwind, properly. The tape retainer may be bent causing undue pressure against the paper roll. The tape feed rollers may not mesh properly or may not have sufficient tension to advance the tape.

(5) A tendency for the paper roll to unwind too fast may be overcome by **slightly** bending a section of the tape retainer.

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513. SPARK SUPPRESSORS.

(a) Condition: Excessive sparking at the timing (Stepping and Printing) contacts at the main shaft.

(b) Probable cause: Excessive spark at the timing contact (Printing) may be caused by failure of the spark suppressor circuit which is composed of a resistor, 400 ohms, and a capacitor, 1 mfd., located to the rear of the keylevers. The capacitor of the timing contact (Printing) is the one located next to the base. To test for failure see para. (e).

(c) Excessive sparking at the timing contact (Stepping) may be caused by failure of the spark suppressor circuit which is composed of a capacitor, 2 mfd., located on top of the one mfd. capacitor referred to in part (b) above. To test for failure see part (e).

(d) To test the resistor, measure the resistance with an ohmmeter.

(e) To test the capacitor:

(1) Disconnect the power lead from the source of power.

(2) Disconnect the brown wire from the clutch magnet. Using a 50,000 ohmmeter touch both terminals of the 1 mfd. capacitor and watch the pointer of the ohmmeter. There should be a momentary deflection of the pointer after which it should rest at infinite ohms. Reverse the leads of the ohmmeter and repeat the operation. If there is not a momentary deflection of the pointer of the ohmmeter or if the pointer does not rest at infinite ohms the capacitor should be changed. Disconnect the terminals of the 2 add. capacitor and test it in the same manner. Replace all leads.

(f) It is realized the above test is not a conclusive test, and is given only because an ohmmeter is generally available, whereas a capacitor tester generally is not. If a capacitor tester is available, it should be used to test the capacitor in lieu of the above tests.

514. CODE WHEELS.

(a) Condition: Code Wheel contacts badly pitted or worn, path between contacts indicates sparking between contacts has occurred.

(b) Probable cause:

(1) Any of the above conditions may be caused by failure of the spark suppressors circuit of the Printing Contact of the main shaft. See para. 513(b).

(c) If a Code Wheel is defective, the best procedure is to exchange the defective set for another set at the nearest Issuing Office which in turn will send the defective set to the nearest ECM Repair Facility for repair. The defective set of Code Wheels should be suitably tagged, indicating the defective Code Wheel, and in such a manner that the defective set will not accidentally be issued before being repaired. If the set cannot be exchanged, the Code Wheel should be repaired locally.

(d) To repair a Code Wheel:

(1) Make a diagram of the wiring, and, if a cam-contoured Code Wheel, the cam-contours.

NOTE: These diagrams shall be classified TOP SECRET, and shall be placed in the custody of a commissioned officer. The diagrams shall be destroyed immediately after a successful test of the repaired Code Wheel.

(2) Unsolder the wires from the solder lugs of the defective face. As much as possible keep them in their relative positions.

(3) Remove the four screws from the face and lift the defective face from the Code Wheel. Remove the corresponding face from an unwired Code Wheel (Part No. 100600 In the Spare Parts Box) and place it on the Code Wheel, making sure that the cam-lobe of the unengraved face is opposite "H" and "I" of the engraved face.

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(4) Resolder the wires.

(5) For cam-contoured Code Wheels, the cam-contours must be added, it is necessary that these be accurately placed. Mark on the Code Wheel the points at which cam-contours are to be added. Cam-contours can be filed into the face with a circular file.

(6) Test the Code Wheel by making several different 26-30 Letter Checks. (For cam-contoured Code Wheels choose Code Wheel Arrangements utilizing the repaired Code Wheel in the center (#3) position).

(7) if both faces must be replaced it is better to repeat the operations for the second face rather than to Individually unsolder each wire from the defective Code Wheel and resolder it on the new one.

(e) Obtain another spare Code Wheel for the Spare Parts Box by ordering it from the most convenient ECM Repair Facility.

515. MOTOR ADJUSTMENT.

(a) The Condition: Machine runs sluggishly, the motor labors, the hand drive operates with difficulty.

(b) Probable cause:

(1) The mesh of the motor pinion and the main shaft drive gear is "too close". The best method of adjustment is to shift to hand drive operation. Adjust the motor adjusting screw until effort is required to turn the main shaft, then back off slightly.

516. CLUTCH MAGNET.

(a) A spare clutch magnet is included in the Spare Parts Box, but replacement should **not** be attempted unless the operator has had training in the replacement. The adjustments required in making a replacement require certain tolerances, some of which are rather critical and unless the operator has been trained and the proper tools are available, it is very difficult to make a repair.

517. RECHECKS REQUIRED.

(a) It is emphasized that the repair operations given in this part are for reference only in the event emergency repairs are required and the services of an ECM Repair Facility are not available. In each instance of an emergency repair, it should be re-checked at the first available opportunity by an ECM Repair Facility.

518. ADJUSTMENT SPECIFICATIONS.

(a) The following tabulation of adjustment specifications is provided for the convenience of repair personnel. It is to be used only by qualified ECM repairmen (holders of CSPM 390 qualification cards - see para. 503).

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ASSEMBLY PARTS INVOLVED	ADJUSTMENTS		
	Min.	Max.	Type*
Keylever Contacts			
Universal Bar and Keylevers	.050	.075	Clearance
All Contacts, less "RPT" and 1-5 outer	.040	.050	Gap
1-5 Keylever outer Contacts	.020	.030	Gap
"RPT" Keylever Contact	.010	.020	Clearance
Universal Contact	.015	.025	Gap
Clutch Contacts			
Inner Contact	.015	.025	Gap
Outer Contact	.025	.040	Gap
Roller and Contact Spring	.025	.045	Clearance
Clutch Mechanism			
Armature and Field Yoke	.010	.020	Clearance
Armature Lever Latching Extension and Clutch Stop Lever Latching Extension (stop position) (old)	.006	.010	Clearance
Armature Lever Latching Extension and Clutch Stop Lever Latching Extension (reset position) (old)	.015	.025	Clearance
Armature Lever Latching Extension and Non-Repeat Latch (stop position) (New)	.002	.006	Clearance
Armature Lever Latching Extension and Clutch Stop Lever Latching Extension (reset position) (New)	.004	.010	Clearance
Clutch Throwout Lever Extension and Clutch Stop Lever Adjustment Screw	.004	.010	Clearance
Main Shaft			

Clutch teeth	.020	.035	Clearance
Channel cam and Stepping Bell Crank Roller	.006	---	Clearance
Timing Contacts			
Print Contact only (old)	.005	.015	Clearance
Stepping Contact only (Old)	.030	.045	Gap
Both Contacts (New)	.006	.015	Clearance
Both Contacts (New)	.015	.025	Gap
Stepping Magnets, Drive Bars and Pawls			
Armature and Armature Back-Stop	.050	.060	Clearance
Armature and Stepping Pawl Latch Adjusting Screw	---	.006	Clearance
Stepping Pawl, latching clearance	.030	.045	Clearance
Zeroize Contacts			
Contact Springs of #3 and #4 Zeroize}	.035	.050	Clearance
Contacts (Stepping) and Code Wheel}	.015	.025	Gap
Printer Tape Feed Mechanism			
Tape Feed Pawl and Ratchet, Controller at "R"	.015	.025	Clearance
Tape Feed Pawl and Ratchet, Controller at "E"	.010	---	Clearance
Tape Feed Pawl and Ratchet, Controller at "R"	.010	---	Clearance
Torque - Tape Feed Shaft	10 to 12 oz. Torque		

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ASSEMBLY PARTS INVOLVED	ADJUSTMENTS		
	Min.	Max.	Type
Printer Stop Pins			
Stop Pin and Stop Pin Latch	1/64"	---	Clearance
Typewheel			
Torque - Typewheel Shaft	14 to 17 oz. Torque		
CSP 1600			
Contact Operating Arm			
Contact operating arm and bottom of cam-contour	.020	---	Clearance
Stepping Contacts			
Contact operating arm and contact spring	.006	.010	Clearance
Contacts	.015	.020	Gap

519. STEPPING CHECKS.

(a) The following chart provides a means of checking the operation of the machine through the first ten-thousand (10,000) steps from the zeroize position.

(b) To make the Stepping Check

(1) Using CSP 1336 (ECM Code Wheel Set C31 to C4), arrange the Code Wheels according to the following Arrangement

Alphabet Maze: 31-32-33-34-35 (All Code Wheels normal,
Stepping Maze: 36-37-38-39-40 (none reversed.

(2) Set the Index Wheels to the following Index Wheel Setting:

18-26-33-43-51

(3) Zeroize.

(4) Set the Controller at "E" (Encipher), and the Zeroizer to "Operate".

(5) Withdraw the paper tape, and reset the Counter to zero.

(6) Using the "Blank" Key, step the Code Wheels, comparing the Alignment of the Code Wheels at the step numbers listed on the chart.

STEPPING CHECK TABLE

CODE WHEEL SETTINGS

Code Wheel Set CSP 1336 (C31-C40)					
Alphabet Maze:	31	32	33	34	35
Stepping Maze:	36	37	38	39	40
Index Maze:	18	26	33	43	51

CODE WHEEL ALIGNMENTS

STEP NO.	ALPH.MAZE	STEP.MAZE	STEP NO.	ALPH.MAZE	STEP.MAZE
0	OOOOO	OOOOO	28	UZWVZ	ONMMO
1	NONNN	ONNNO	29	TYTVY	ONLMO
2	MONNM	ONMNO	30	TYSUY	ONKMO
3	LOMMM	ONLNO	40	NTLMS	ONAMO
4	KNLMM	ONKNO	50	FMGGP	ONQMO
5	KMKML	ONJNO	60	ZEZBI	ONGLO
6	JLJLL	ONINO	70	TXTXF	ONWLO
7	JLIKK	ONHNO	80	MTNQZ	ONMKO
8	ILHKK	ONGNO	90	ENGLS	ONCKO
9	HKHKJ	ONFNO	100	ZGBCP	ONSKO
10	GKHJI	ONENO	200	HCHSN	ONWGO
11	FJGII	ONDNO	300	TRUIK	ONACO
12	EJFHI	ONCNO	400	DNGAM	ONEYO
13	EJEGI	ONBNO	500	PBOPM	ONIUO
14	DJEFH	ONANO	600	AUVGL	ONMQO
15	CIDEH	ONZNO	700	HGJVP	OMQNO

16	BHCEH	ONYNO	800	PCSSN	OMUJO
17	AGCEH	ONXNO	900	WVEML	OMYFO
18	ZGBEG	ONWNO	1,000	ILOGK	OMCBO
19	YFADG	ONVNO	2,000	EFPWI	OLQPO
20	YEZCG	ONUNO	3,000	EWIVO	OJECO
21	YDYBF	ONTNO	4,000	HCGSE	OISQO
22	YDXAE	ONSNO	5,000	VSBGP	OGGDO
23	YCWZD	ONRNO	6,000	SVQUG	OFURO
24	XCWYC	ONQNO	7,000	VOHMY	ODIEO
25	WCWXB	ONPNO	8,000	TPPCV	OCWSO
26	VBVXA	ONONO	9,000	JROHC	OAKFO
27	UAUXA	ONNMO	10,000	ZSRBB	OZYT0

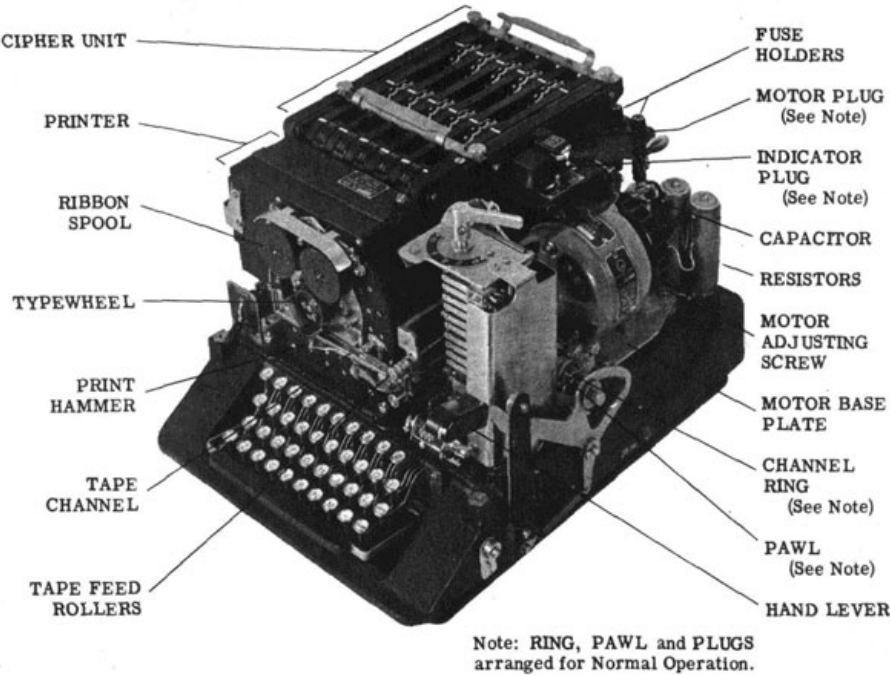


PLATE 5

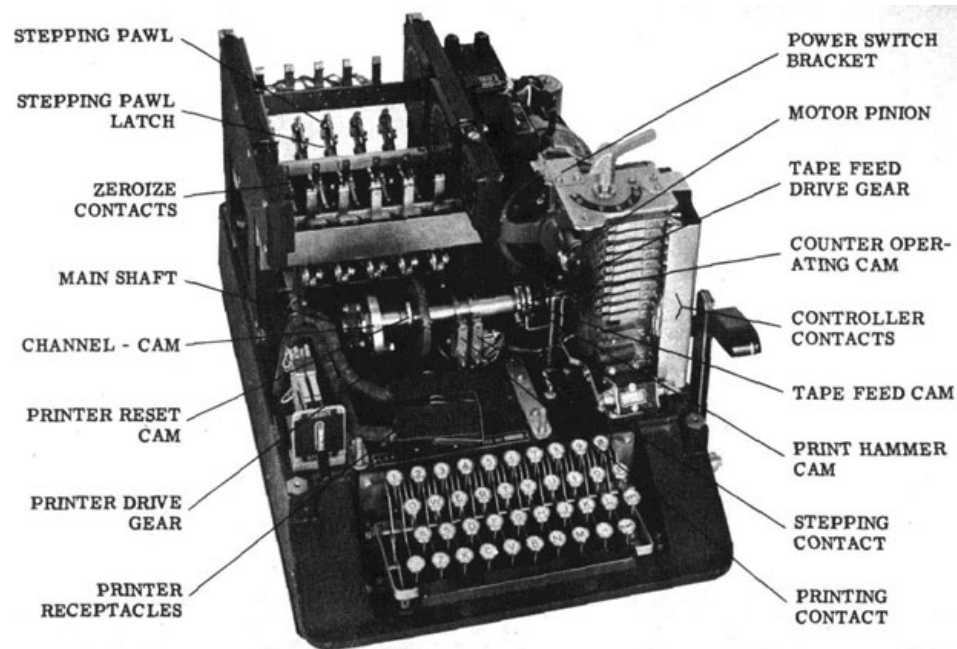


PLATE 6

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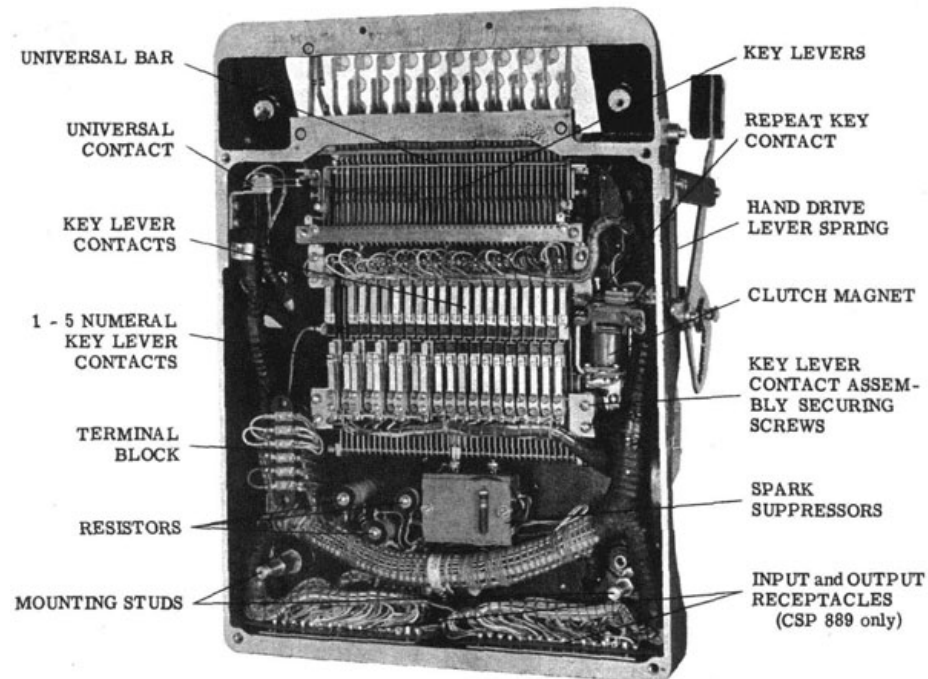


PLATE 7

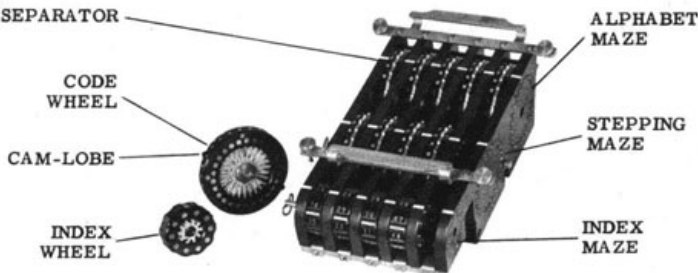


PLATE 8A - CIPHER UNIT

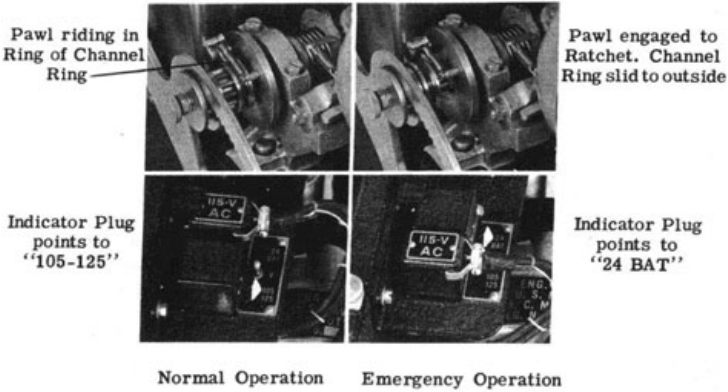


PLATE 8(B)

PLATE 8(C)

PLATE 8

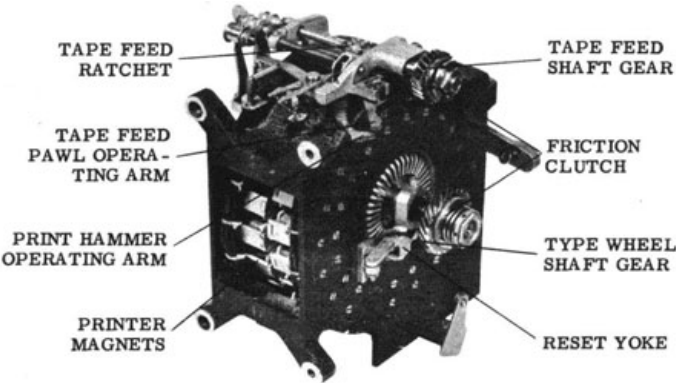
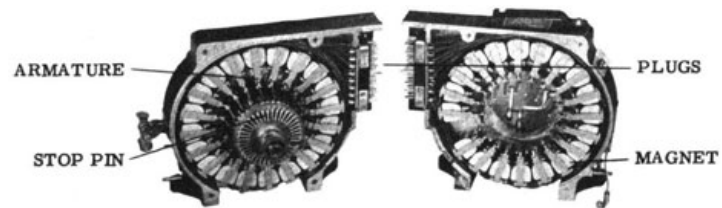


PLATE 9A - PRINTER



CAUTION: Under no circumstances will the Printer Unit be opened by inexperienced personnel.

PLATE 9 B - PRINTER UNIT (Opened)

PLATE 9

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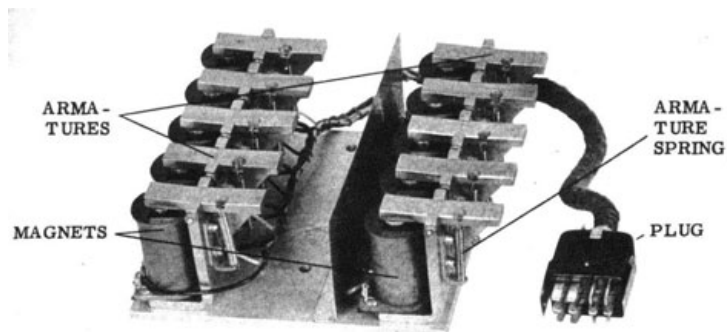


PLATE 10A - STEPPING MAGNET ASSEMBLY



PLATE 10B - TAPE MOISTENER and CUTTER

PLATE 10

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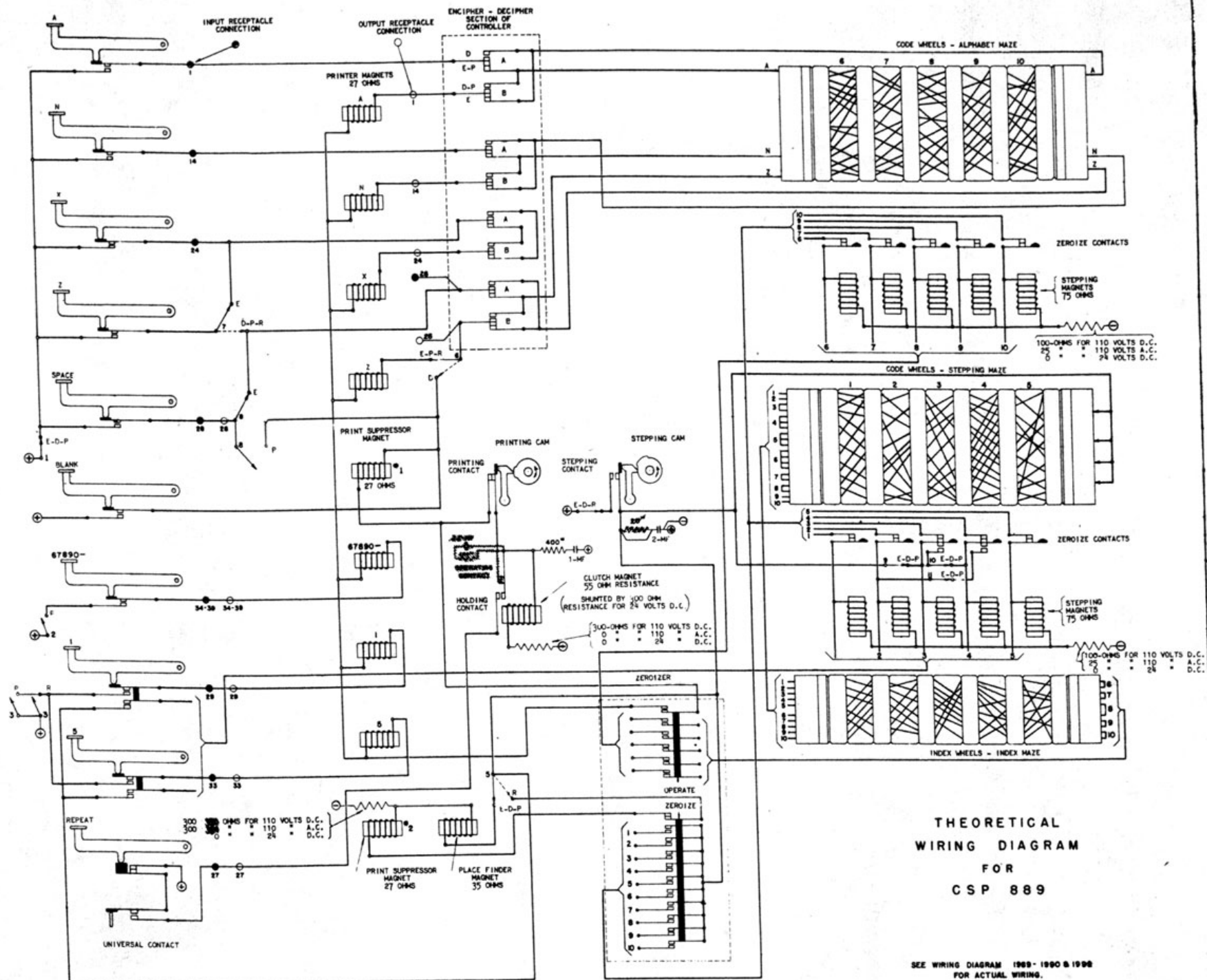


PLATE 11

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BLANK

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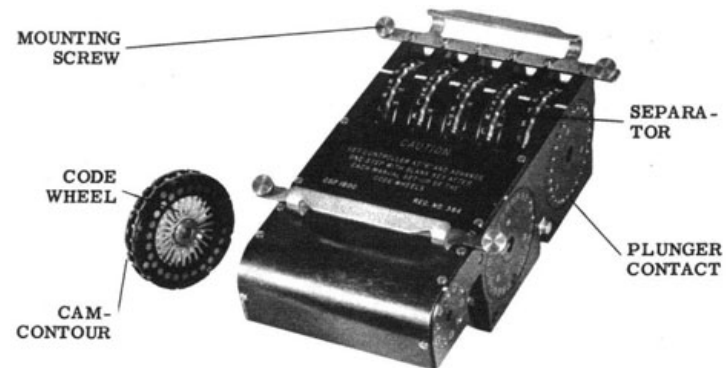


PLATE 12A - CCM MARK 1 - CSP 1600

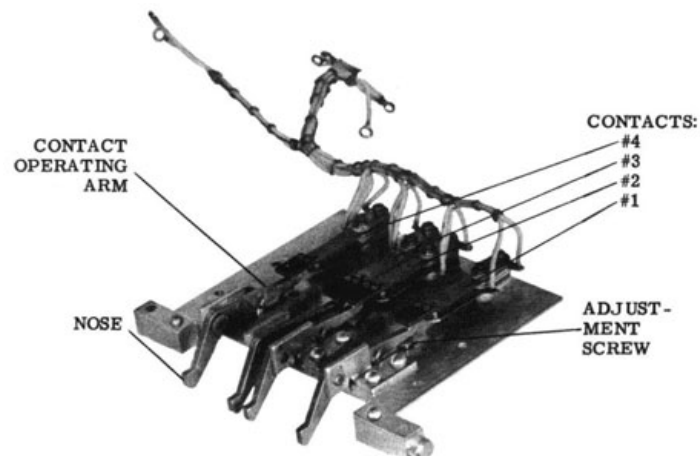


PLATE 12B - CONTACT ARMS and CONTACTS
PLATE 12

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PART VI

CCM MARK 1

601. GENERAL.

(a) The Combined Cipher Machine Mark 1 (CSP 1600) is a device which converts the ECM Mark 2 to the cryptographic equivalent of the CCM. The CCM Mark 1 is a unit similar to the ECM Mark 2 Cipher Unit. All alterations and modifications are contained within the unit and no change in the ECM Mark 2 is necessary except to insert CSP 1600 into the machine in place of CSP 887.

NOTE: When not in use, CSP 1600 is to be kept in the special metal box provided with each unit. It shall be securely fastened with the four thumb screws.

602. CODE WHEELS.

(a) The Code Wheels used with CSP 1600 are similar to those used with the ECM Mark 2 except that cam-contours have been cut at irregular intervals on the periphery of each face for the purpose of actuating the Stepping Magnet Contacts, and the cam lobes have been ground off.

603. DESCRIPTION.

(a) The unit is so constructed that only five Code Wheels of the set are used at a time. These Code Wheels (together with the connections established through the plunger contacts) form the Alphabet Maze.

(b) Four Stepping Magnet Contact Operating Arms and associated Contacts are included in the unit. Their function is to control the stepping of the Code Wheels. Each Contact Operating Arm is so positioned that the nose of the Contact Arm rides the periphery of a Code Wheel. As the Code Wheel is turned, the nose drops into a cam-contour thus closing the contact. When the nose rides the periphery of a Code Wheel the contact is held open. The Code Wheel controlled by this contact will step in accordance with the cam-contours on the controlling Code Wheel.

NOTE: IT IS A REQUIREMENT THAT THE STEPPING CONTACTS BE CAREFULLY ADJUSTED SO THAT THE CONTACT WILL BE POSITIVELY "OPENED" OR "CLOSED", DEPENDING UPON THE POSITION OF THE CAM-CONTOURS OF THE CODE WHEEL.

(c) Stepping Circuit connections are established for the circuits of the machine through two plunger contacts on the right end plate of the former Stepping Maze and through five plunger contacts of the former Index Maze.

604. STEPPING CONTROL.

(a) The Code Wheels are stepped as follows:

(1) The #3 (center) Code Wheel is stepped one letter with each Keyboard stroke, and actuates the two center (#2 and #3) Stepping Magnet Contacts.

(A) The left center (#2) Contact controls the stepping of #2 Code Wheel,

(B) The right Center (#3) Contact controls the stepping of #4 Code Wheel.

(2) The left (#1) Contact is actuated by #2 Code Wheel, and controls the stepping of #1 Code Wheel.

(3) The right (#4) Contact is actuated by #4 Code Wheel, and controls the stepping of #5 Code Wheel.

(b) The Stepping Control thus originates with the center Code Wheel and progresses to each side.

(c) The ECM Mark 2 prints and then steps whereas some machines cryptographically equivalent step and then print This requires an additional "Blank" step when using the CCM Mark 1 after each manual alignment of the Code Wheels in order to bring the machine into proper step On encipherment, the Controller is set at "R" (Reset) when depressing the "Blank" key, and then set at "E" (Encipher) in order that the first letter of the encipherment will be the initial letter of the first five letter group

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605. PREPARATION.

(a) The ECM Mark 2 is prepared for operation in the normal manner, except that CSP 887 Is replaced by CSP 1600 and associated Code Wheels.

606. KEY LIST.

(a) Each CCM Key List contains:

(1) The Code Wheel Arrangement.

(2) The 26-30 Letter Check.

(3) One or more Initial Code Wheel Alignments.

(b) The following illustrations are examples of the two CCM Key Setting Forms most generally used. They are based on CSP 1811.

(1) For U.S. Navy use:

CODE WHEEL ARRANGEMENT: -----	14R 11 13 17R 15
26-30 LETTER CHECK: -----	26-30 Ltr Ck: DMOSH
INITIAL } (for SECRET messages-----	SEC: DWVAP
CODE WHEEL } (for CONFIDENTIAL messages-----	CON: HNYST
ALIGNMENTS } (for RESTRICTED messages-----	RES: FEIGS

(2) For Combined (United States - British use):

CODE WHEEL ARRANGEMENT -----	17 16R 11R 13 19R
26-30 LETTER CHECK -----	26-30 Ltr. Ck: AODOT
INITIAL CODE WHEEL } {-----	Initial Alignment:
ALIGNMENTS } {-----	(A) SXTED
	(B) BSDQI

(c) The Code Wheel Arrangement consists of five numbers corresponding to the numbers engraved on the Code Wheels. Any letter prefixes or suffixes of the individual Code Wheel designations are omitted and in some Key Lists only the final digit may be shown.

(d) The 26-30 Letter Check is given as a means of checking the Code Wheel Arrangement and the operation of the machine.

(e) The Initial Code Wheel Alignment is provided for encipherment of the Message Code Wheel Alignment. Para. (b) (1) Illustrates a Key Setting designed for U. S. Navy use only, and gives three Initial Code Wheel Alignments, designated "SEC", "CON" and "RES" to be used for SECRET, CONFIDENTIAL and RESTRICTED messages respectively. Para. (b) (2) illustrates a Key Setting designed for Combined use, and gives two Initial Code Wheel Alignments, designated "A" and "B" respectively. The Key List in use will define, by means of a footnote, the classifications of messages for which "A" and "B" are to be used.

607. DEFINITIONS.

(a) In this method of operation, two different Code Wheel Alignments are used, requiring differentiation.

(1) The **MESSAGE CODE WHEEL ALIGNMENT** Is the alignment appearing on the Code Wheels at the start of the actual encipherment of the message. It consists of five letters selected at random.

(2) The **INITIAL CODE WHEEL ALIGNMENT** is the alignment used in the process of enciphering (or deciphering) the Message Code Wheel Alignment It is given in the Key List

(b) The INTERNAL INDICATOR is the encipherment of the Message Code Wheel Alignment, using the Initial Code Wheel Alignment at the beginning of the encipherment

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(c) The EXTERNAL INDEATOR is provided for by the Key List, Rotating Indicator List, Crypto-Channel Charts, etc. Many of the crypto-channels in which the CCM is used have been assigned several Rotating Indicators for each classification. It is important that these indicators be used equally and in random order, and checked off as used so that an Indicator will not be used again until all the others have been employed, and so that an alphabetical or other pattern will not be apparent.

608. CODE WHEEL ARRANGEMENT.

(a) Remove CSP 1600 from its metal box by unscrewing the four thumb screws.

NOTE: CSP 887 may be stowed in the metal box while CSP 1600 is in use.

(b) Determine the proper set of Code Wheels to be used. Each Key List contains this information in the Instructions. Choose the Key Setting corresponding to the date of the Date/Time Group to be used in the message. Insert the Code Wheels in CSP 1600 in accordance with the Code Wheel Arrangement given in the Key Setting.

(1) The sequence given is positions #1 to #5 inclusive, for respective Code Wheel positions in CSP 1600. The letter "R" appearing after a Code Wheel number indicates the Code Wheel so designated is to be inserted in a reversed position (I.e., with the letters appearing upside down to the operator). Insert the Code Wheel Spindle and install CSP 1600 in the machine, securing it carefully by means of the four thumb screws.

609. 26-30 LETTER CHECK.

(a) The 26-30 Letter Check is provided for checking the Code Wheel Arrangement and operation of the machine. The five letter group given is the encipherment of the letter "A" on the 26th to 30th steps inclusive using the Code Wheel Arrangement given in the Key Setting with an Initial Code Wheel Alignment of "OOOOO".

THE 26-30 LETTER CHECK SHALL BE MADE AFTER EACH CHANGE OF CODE WHEEL ARRANGEMENT. ITS USE IS MANDATORY

(b) To make the 26-30 Letter Check:

- (1) Prepare the machine for operation.
- (2) Insert the Code Wheels according to the Arrangement given in the Key.
- (3) Set the Code Wheels by hand to an Initial Alignment of "OOOOO".
- (4) Set the Controller at "R" (Reset) and set the Zeroizer to "Operate". By means of the "Blank" Key, step the Code Wheels once.
- (5) Set the Controller at "E" (Encipher), and reset the Counter to zero. By means of the "Blank" and "Repeat" Keys, step the Code Wheels twenty-five times.
- (6) Type (Encipher) the letter "A" five times.
- (7) Compare the resultant encipherment with the values given in the Key. Any deviation necessitates a complete re-check.

(c) If the correct 26-30 Letter Check is not produced see pars. 308(d).

610. ENCIPHERMENT.

(a) Having arranged the Code Wheels in accordance with the Key Setting and having made the 26-30 Letter Check:

- (1) Set the Controller at "P" (Plain), and set the Zeroizer to "Operate". When using CSP 1600 the Zeroizer is set at "Operate" for all operations. Type the heading, Date/Time Group, etc., and any other data desired. Press the Tape release tab and advance the tape two or three inches, or space several times. Type the External Indicator and space once.

(2) Select at random a group of five letters to use as the MESSAGE CODE WHEEL ALIGNMENT. Make a note of the five letter group on the message being enciphered for a reference purpose in case a verification is requested.

CAUTION: THE MESSAGE CODE WHEEL ALIGNMENT FOR EACH MESSAGE ENCIPHERED BY A PARTICULAR KEY SETTING MUST BE DIFFERENT. THE SELECTION OF THE LETTERS MUST BE ENTIRELY AT RANDOM, THE LETTERS "O" AND "V" MUST NOT BE USED, AND THE LETTERS MUST NOT FOLLOW A REGULAR SYSTEM OF PROGRESSION. (See para. 329.)

(3) Select, from a Key Setting, the appropriate Initial Code Wheel Alignment for the classification of the message, and set the Code Wheels, by hand, to the reference lines in accordance with the designated letters. Set the Controller at "R" (Reset) and, by means of the "Blank" key, step the Code Wheels once, This is necessary because the CCM Mark I enciphers (or deciphers) and then steps the Code Wheels, whereas other devices cryptographically identical step the Code Wheels and then enciphers (or deciphers). (If the Controller is set at "E" when this is done, the machine will be in step, but the spacing of the five letter code groups will be displaced one letter.)

(4) Set the Controller at "E" (Encipher), and type (encipher) the MESSAGE CODE WHEEL ALIGNMENT (the five letter group selected at random in Paragraph (2) above.) This encipherment produces the INTERNAL INDICATOR.

(5) Set the Code Wheels, by hand, to the **MESSAGE CODE WHEEL ALIGNMENT**. Set the Controller at "R" and, by means of the "Blank" key, step the Code Wheels once.

(6) Set the Controller to "E" (Encipher), reset the Counter to zero.

(7) Type the text to be enciphered, using the space bar and alphabet keys only. Spell out numerals. The letter "X" shall normally be used to represent every mark of punctuation. When necessary for clarity, punctuation marks may be spelled out The only abbreviations for punctuation authorized are PAREN, PARA, and QUES. All punctuation shall be kept at a minimum and used only when necessary to attain clearness. The enciphered text will appear on the tape in groups of five letters. When padding is added at either or both ends to conceal a particularly short message, one in stereotyped form, or one which has been or may be encrypted in another system, the use of spaces and other stereotyped padding must be avoided. (See Chapter IV, **Communication Instructions** for example of objectionable padding.)

(8) When the text has been completely enciphered, note the counter reading. If it is not a multiple of five, set the controller to "P" (Plain), and type the letter "X" as many times as are needed to produce a reading which is a multiple of five. Space once.

(9) Set the Code Wheels, by hand, to the INITIAL CODE WHEEL ALIGNMENT. Set the Controller at "R" (Reset) and space once. Set the Controller at "E", and type (encipher) the MESSAGE CODE WHEEL ALIGNMENT. Check this group with the first INTERNAL INDICATOR

(10) Set the Controller at "P" (Plain) and type the EXTERNAL INDICATOR. Advance the tape through the tape channel until all the printing is clear, and tear off the tape.

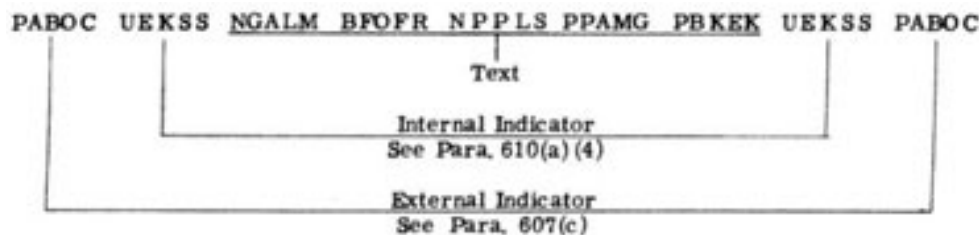
611. CHECK DECIPHERMENT.

(a) As a check on accuracy, an enciphered message shall be check-deciphered prior to transmission, preferably by another coding officer, and if available, on a second machine using a different set of Code Wheels. In an emergency the check-decipherment may be deferred until after transmission, but should be completed as soon as possible. THE CHECK-DECIPHERMENT IS MANDATORY.

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612. EXAMPLE.

(a) The following example represents the appearance of a message enciphered in this manner. It is based on the sample Key Setting shown in para. 606 (b) (2). It is assumed PABOC is the CONFIDENTIAL External Indicator.



613. MESSAGE LENGTH.

(a) Very long messages to be enciphered with the CCM Mark 1 should be broken up into parts, each of which uses a different Message Code Wheel Alignment. Each part should not exceed two-hundred (200) groups in length.

614. DECIPHERMENT.

(a) Using the Code Wheel Arrangement of the Key Setting as determined by the Date/Time Group, prepare the machine for operation. Make the 26-30 Letter Check.

(b) If any plain text is desired, set the Controller at "P" (Plain) and set the Zeroizer at "Operate". When using CSP 1600, the Zeroizer is set at "Operate" for all operations.

(c) Select from the Key Setting, the appropriate Initial Code Wheel Alignment for the classification of the message and set the Code Wheels, by hand, to the reference lines in accordance with the designated letters. Set the Controller at "R" (Reset) and, by means of the "Blank" key, step the Code Wheels once. Set the Controller at "D" (Decipher). Disregard the External Indicator, and type (decipher) the Internal Indicator (the second and next-to-the-last groups of the message). This decipherment produces the **MESSAGE CODE WHEEL ALIGNMENT**.

(d) Set the Code Wheels, by hand, to the Message Code Wheel Alignment, just obtained. Set the Controller at "R" (Reset), and by means of the "Blank" key, step the Code Wheels once.

(e) Set the Controller at "D" (Decipher), and reset the Counter to zero. Type (decipher) the text of the message.

615. CLEARING GARBLES.

(a) If the letters of the Internal Indicator at the beginning and end of the message are not identical (due to errors of transmission) try the various combinations until a Message Code Wheel Alignment Is obtained that will give intelligible text.

(b) The External Indicator of one classification may have been used in the message whereas, an Initial Code Wheel Alignment of another classification may have been erroneously employed.

(c) On decipherment if an "X" appears as a letter of the Message Code Wheel Alignment and the message does not "break" try substituting a "Z" for the "X".

(d) On decipherment, if a blank space appears as a letter of the Message Code Wheel Alignment, try substituting a "Z" for the blank spaces.

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ADJUSTMENTS

616. STEPPING MAGNET CONTACTS.

(a) Plate 13 illustrates the action of a Contact Operating Arm as controlled by the Cam-contours of the Code Wheel. Plate 13A shows the nose of the Contact Operating Arm resting in a cam-contour, permitting the contact to close, and Plate 13B shows the nose of the Contact Operating Arm "riding" the periphery of the Code Wheel, holding the Contact open.

CAUTION: IT IS A REQUIREMENT THAT THE STEPPING MAGNET CONTACTS POSITIVELY "MAKE" OR "BREAK" OTHERWISE CORRECT ENCIPHERMENT OR DECIPHERMENT IS IMPOSSIBLE.

611. CONTACT ADJUSTMENTS.

(a) To check the adjustment of the Stepping Magnet Contacts:

(1) Insert the Code Wheels in accordance with the Code Wheel Arrangement to be used.

(2) Rotate, by hand, the #3 (center) Code Wheel and observe the action of either the left center (#2) or right center (#3) contacts.

(A) When the nose of the Contact Operating Arm drops into a Cam-contour of the Code Wheel, the associated contact should be positively "closed" and the nose should not touch the bottom of the Cam-contour. This condition can be tested by rocking the Code Wheel back and forth slightly and observing the points at which the Code Wheel moves the Contact Arm.

(B) When the nose of the Contact Operating Arm rides the periphery of the Code Wheel the contact should be positively "opened".

(b) To adjust the Stepping Magnet Contacts:

(1) Rotate the Code Wheel until the nose of the Contact Arm is on the periphery of the Code Wheel. If necessary, bend the lower contact spring until the contact is "just open".

(2) Rotate the Code Wheel until the nose of the Contact Operating Arm drops into a Cam-contour. It should require only slight pressure to break the contact between the upper and lower contact springs. Adjust by bending the upper contact spring. The nose of the contact arm should clear the bottom of the cam-contour and the push-end of the contact operating arm should "barely clear" the upper Contact spring insulator. This adjustment is made by turning the adjustment screw.

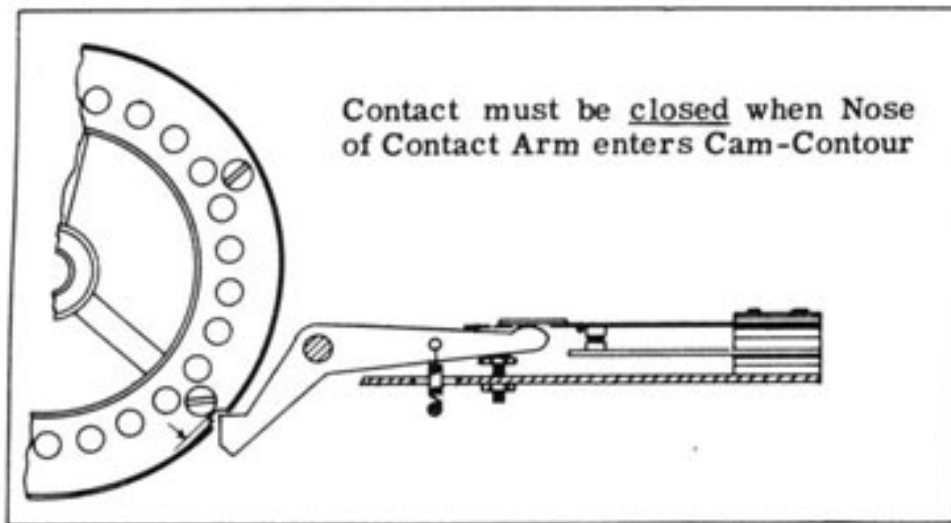


PLATE 13A

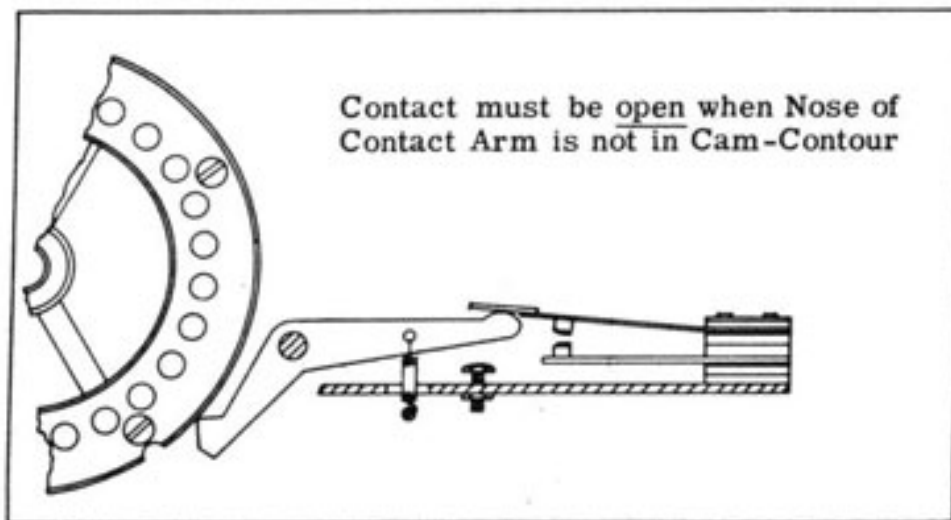


PLATE 13B

PLATE 13

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BLANK

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BLANK

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CSP 1100(C)

CONFIDENTIAL

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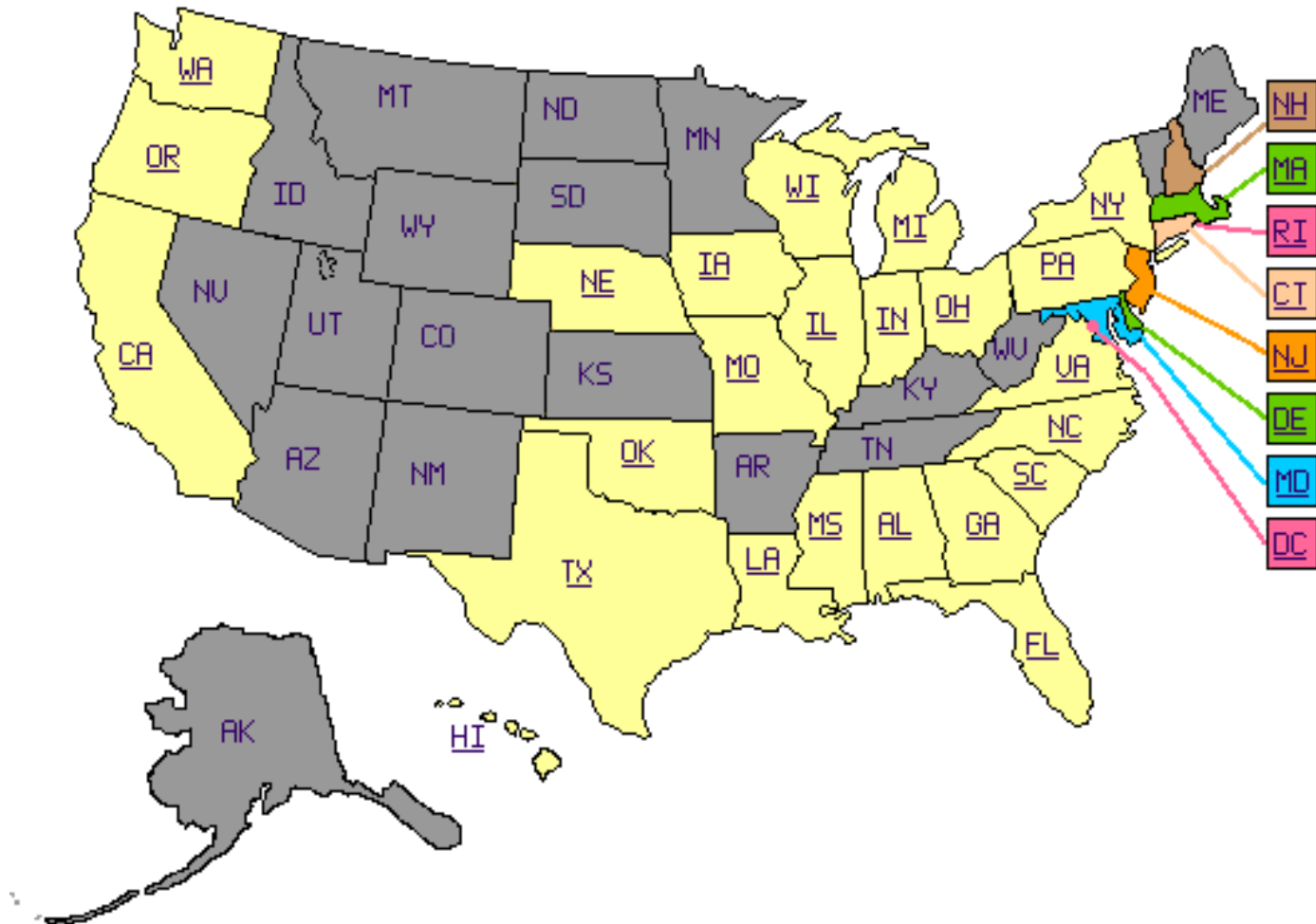
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